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PHILIPS

SERVICE

Scientific & Analytical Equipment
Test & Measuring Instruments
Industrial Automation
Advanced Automation Systems
Welding

Scientific & Industrial Equipment Division

850128 PW1400/00 XRA 228

Already issued: XRA 141, 142, 150, 153, 157, 162, 167, 169, 175, 178, 179, 183, 196, 198, 203, 206, 209, 221, 222, 223 and 226.

Subject: D.C. Motor Drive for Primary Collimator

Action: To be introduced when the Oil-filled buffer (Service Manual page 8-90, item 95, Shock absorber assembly) needs replacement.

INTRODUCTION

Practice has shown us that the compressed air primary collimator drive with the oil-filled damping cylinder has not been very reliable. Moreover, leaking oil-filled buffer cylinders have caused damage to the collimator.

Although 100% incoming inspection and outgoing test procedures have been introduced and have improved the quality of the buffer cylinder, it remains a difficult product to manufacture and keep the reliabilty at an acceptable level.

Therefore it has been decided to equip our latest Sequential Spectrometer the PW1404 with a d.c. motor driven collimator instead of the air driven version. This d.c. motor drive is being made available for the PW1400/00 to replace the existing compressed air drive mechanism, which will be withdrawn from the Spare Parts stock.

The modification kit for the PW1400/00 contains the following parts (refer to figure 1):

A. D.C. motor drive unit to be mounted on the crystal chamber replacing the compressed air drive assembly.

   This unit is the same as the PW1404 drive unit.

B. Control board (U1) to control the d.c. motor drive unit. This board must be mounted onto the left-hand side of the PW1400/00 electronics rack.

   This board is specially made for the PW1400/00 and contains the relevant circuits taken from the electronics of the PW1404.

C. Additional parts: Cable loom together with plugs and wires and all required mounting materials, and a 1 kOhm resistor.

ORDERING CODE: 5322 694 14755

PRICE: Price code: 107H PIF 26 Factor 1.4

IMPORTANT: Since this replacement kit is meant to improve the reliability of the collimator drive, it has been put in the price catagory PIF 26; which means that it has been given a subsidised price. Please take this into consideration when setting your price.

9499 308 19411

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GENERAL DESCRIPTION

GENERAL DESCRIPTION (Refer to Figure 4.6.2 in the PW1400/00 Service Manual, and figures 2, 5 and 7 of this XRA)

The signals COLVC+ and COLVF+ on connector X8 pins A23 and C23 [D-6] are used to control the electro-mechanical valves Y8 (fine) and Y9 (coarse) [B-12] in the compressed air system. When the new d.c. motor is installed only one of these signals is used: COLVF+, this signal is connected to the motor control board U1 which controls the d.c. drive motor. Both the signal wires are disconnected from the plug and cut back. The wire carrying the signal to the motor control board U1 (point 1) is connected to X8-C23.

The signals COCSD- and COFSD- coming from the microswitches S26 and S27 [A-12] on pins A18 and C19 of X8 indicate whether the fine collimator or the coarse collimator is in position and must be connected to the motor control board U1. Both of the wires are disconnected from X8 and soldered to wires connected to the motor control board U1 (points 2 and 3). These signals cause the motor drive to switch over from high speed to low speed when the contact of the relevant microswitch is released.

The signals COFSD- and COCSD- which come from the motor control board U1 (points 9 and 10) are connected to the system status circuit, they are connected to X8-C19 and X8-A18 [A16].

When the collimator has reached an end stop (fine or coarse) the d.c. motor holds the collimator in position by continuing to apply torque.

MOUNTING INSTRUCTIONS

A. D.C. motor drive unit. (Refer to figures 3 of this XRA also figure 4 of this XRA which is a corrected version of figure 8.2.2 of the PW1400/00 Service Manual).

1. Remove the crystal chamber cover.
2. Remove the crystal changer.
3. Loosen the two fixing screws (item 17) and remove the gear wheel (item 44).
4. Remove the thick vacuum hose from the sample chamber input to allow you access to the collimator drive assembly.
5. Make a note of the electrical connections to microswitches S26 and S27 on the collimator drive, and S28 on the mask drive, and remove the connections (on some of the older equipments you may have to unsolder the connections). The microswitches are in the same position on the new drive unit and will need to be connected up the same way as the microswitches that you have just disconnected.
6. Loosen and remove the air cylinder/oil buffer assembly (item 95), the compressed air cylinder assembly (item 47) and the mounting plate assembly (item 26) as follows:
   a. Remove gear wheel (item 29).
   b. Remove the assembly consisting of the three microswitches S26, S27 and S28 from the mounting plate (item 26).

c. Remove the mounting plate (item 26) from the feed-through flange (item 9).

d. The feed-through flange (item 9) has been vacuum sealed to the crystal chamber with "Silastic" sealing compound, this means that you must break the seal as follows:

1. Remove the three bolts (items 10) holding the flange to the crystal chamber.

2. Screw one of the bolts that you just removed, into one of the holes that were used to secure the mounting plate (item 26) onto the flange, and then tighten the bolt until the flange is pushed away from the crystal chamber breaking the seal.

3. Remove the bolt that you just used to break the seal and remove the flange.

e. Scrape the "Silastic" compound away from the mounting surface of the crystal chamber, and polish this surface with very fine emery cloth (No. 500). Then clean the surface and the feed through hole with a clean cloth and some petroleum ether (this surface will be used for the o-ring vacuum seal).

7. Before you mount the new motor drive unit you must first note how the microswitch assembly is mounted on the unit, and then remove it from the unit. Then if it has not already been done in the factory, position the microswitch cams so that they are opposite each other (180° apart).

Moreover the cams must have been mounted on the shaft such that, with microswitch S27 released and hence S26 pressed, the fixing screws are pointing to the electrical connections of S26/S27. This is to prevent the microswitch roller from rolling over the fixing screws.

8. Grease the supplied o-ring with Apiezon M vacuum grease and then mount it onto the flange of the new motor drive unit, and then mount the new motor drive unit and tighten the three securing screws.

9. The gear wheel (item 44) will be fitted onto the collimator drive shaft inside the crystal chamber during the adjustment procedure, when you do that, make sure that there is clearance between the gear wheel and the crystal chamber.

10. Check that the microswitches are positioned in the middle of their adjusting range in their housings and remount them onto the motor drive unit.

11. Make the electrical connections to the microswitches S26, S27 and S28 as noted in step 5.

B. Control Board U1. (Refer to figures 2, 4, 6 and 7 of this XRA and figure 4.6.2 of the PW1400/00 Service Manual).

1. Mount the printed circuit board on its mounting plate onto the left-hand side of the electronics rack using the bolts supplied.

2. Connect the 10-pole plug on the cable loom to the 10-pole connector on the printed circuit board. Pin 1 is indicated on both the plug and the board.

3. Connect the 2-wire cable with the grey sleeve to the drive unit d.c. motor connector block. The cable has a brown wire (item 7) and a white wire (item 8), each of these has a connector soldered on the end which should be connected as follows:

   Brown wire (7) to + of the motor (the red wire from the motor is also connected)

   White wire (8) to - of the motor (the black wire from the motor is also connected)

4. The three wires (items 4, 5 and 6) of the cable branch X14/X15 must be connected to free pins on connectors X14 (Power Supply 12V) and X15 (Bus Interface) as follows:

   Yellow wire (4) to pin X15-A03 : +12V

   Black wire (5) to pin X15-A32 : +0V

   Green wire (6) to pin X14-A26 : -12V

5. The five wires (items 1, 2, 3, 9 and 10) of the cable branch X8 must be connected to the wiring of X8 (Spectrometer Control) as follows:

   a. Disconnect the violet wire from X8 pin C23 and cut it back (it is not used any more), and then connect the violet wire (19) from the loom to X8-C23. This carries the signal COLVF+ to the Control Board U1.

   b. Disconnect the blue wire from X8 pin A23 and cut it back (it is not used any more). The signal COLVC+ on this pin is no longer used.

   c. Disconnect the yellow wire from X8 pin A18 and cut off the connector, strip the end of the wire and solder it to the yellow wire (3) from the loom (use the supplied shrinking sleeve to insulate the joint). This wire carries the signal COCSD- from the microswitch S26 to the Control Board U1.

   d. Disconnect the grey wire from X8 pin C19 and cut off the connector, strip the end of the wire and solder it to the grey wire (3) from the loom (use the supplied shrinking sleeve to insulate the joint). This wire carries the signal COFSD- from the microswitch S27 to the Control Board U1.

   e. Connect the grey wire (9) from the loom to X8 pin C19. This wire brings the signal COFSD- to the System Status circuit in the PW1400/00.

   f. Connect the yellow wire (10) from the loom to X8 pin A18. This wire brings the signal COCSD- to the System Status circuit in the PW1400/00.

6. Bend up (out of the way) the three unused connector tags on the d.c. motor connection block, and then connect the thick vacuum pipe up again.

7. Remove the supply voltages from the electro-mechanical valves Y8 (fine) and Y9 (coarse) [B-12] in the compressed air system. These valves are no longer used.

C. 1 kOhm Resistor. For Power Supply Board A14 (+12 V/-12 V).
(Figures: For PE1274 and PE1378, refer to figure 4.10.1 on page 4-326 of the PW1400 Service Manual, and figure 313 of Eurocard D.C. power supply manual PE1271 - PE1274/00/10).

1. The value of R121, the +12 V supply current limiting resistor must be changed to 1 kOhm. This changes the current limiting action from 1 Ampere to 1.4 Ampere; this is required to prevent a disturbing voltage drop when the d.c. motor draws a momentary high current when starting and stopping.

ADJUSTMENT PROCEDURE

1. Turn the shaft to a position where the roller of microswitch S26 (coarse collimator) is in the middle of the flat part of its cam.

2. Rotate the collimator by hand against the coarse collimator endstop, and slide the gear wheel (item 44) onto the drive shaft in the crystal chamber, engaging the collimator gear. Press the collimator against the endstop and fix the gear wheel on to the shaft with the two fixing screws. Keep a clearance between the gear wheel and the crystal chamber.

3. Switch the spectrometer on and give the command "COL F". The d.c. motor will drive the collimator at a fast rate to the fine position and switch to a slow speed when microswitch S27 is released. This must happen between 10 and 15 degrees before the endstop, if it does not, adjust the microswitch until it does. Repeat the test for the coarse collimator using the command "COL C" and microswitch S26.

4. Adjust microswitch S28 of the mask changer so that it functions properly.

CIRCUIT DESCRIPTION OF CONTROL BOARD U1

The collimator is moved from COARSE to FINE and vice-versa by means of a d.c. motor. There are six modes (motor states) for the control electronics, these modes are:

1. Move fast towards FINE.
2. Move slowly towards FINE.
3. FINE position with holding torque.
4. Move fast towards COARSE.
5. Move slowly towards COARSE.
6. COARSE position with holding torque.

The control signal COLVF+ controls which collimator is selected (high = FINE collimator selected; and low = COARSE collimator selected).

There are two microswitches used to sense when the collimator is near or in one of its end positions. The actuation of one of these microswitches (in modes 3 or 6) causes either COFSD- (FINE selected) or COCSD- (COARSE selected) to be present.

There are three gating/control signals on i.c. D2:

On pin 11 : High = motor move towards FINE
Low = motor move towards COARSE

On pin 10 : High = motor speed SLOW
Low = motor speed FAST

On pin 9 : High = motor running
Low = motor stopped

The setpoint voltages for the direction of rotation, and FAST and SLOW speeds are derived from the resister network: R2, R3, R4 and R5. The voltage levels are dependant on where in the network the voltage is selected. Figure A shows a simplified diagram of the control board, and the resistor network is shown on the left of that diagram.

The "holding torque" is fed back via resistors R14, R23 and R13.

The "speed" is fed back via D3-5 and D3-6. The voltage at D3-7 is a measure of the speed (modes 1, 2, 4 and 5).

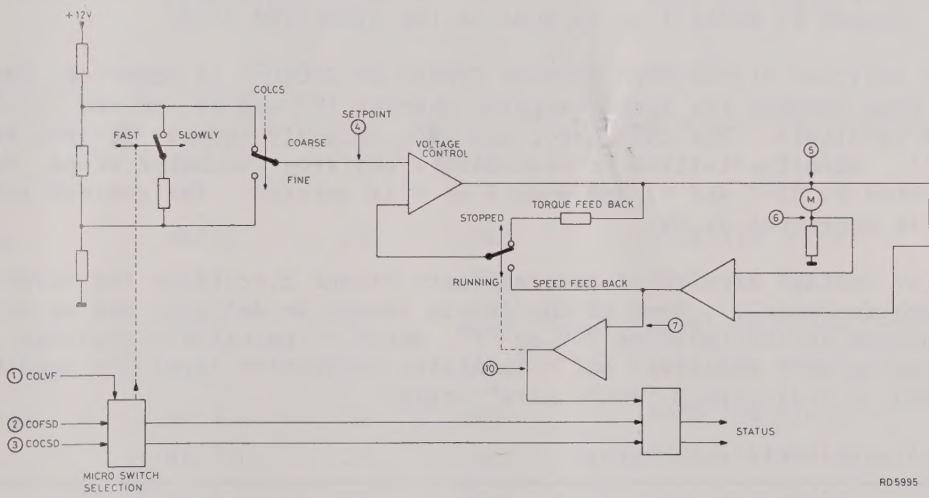

Figure A.

When the collimator is at one of its end positions the motor is stopped and does not generate a back-EMF (modes 3 and 6), in this situation only the d.c. resistance value (about 7 ohms) is important, this results in a voltage at D3-7 of about zero. Both D3-8 and D3-14 are low (negative), this means that D2-9 is low, connecting D2-5 (torque control level) to D2-4. The low level is also connected to the OR gates D4-8 and D4-12, enabling the status information from the microswitches S26 and S27 to be reflected on pins 9 (COFSD- collimator FINE selected) and 10 (COCSD- collimator COARSE selected).

When the motor is running, the voltage division between the motor and R10 changes with the changing back-EMF. The voltage at D3-7 is either > +0,7 V, or < -0,7 V; if it is more than +0,7 V, D3-8 is set high, and if it is lower than -0,7 V, D3-14 is set high. A high level on either of these is connected to D2-9, switching the voltage level on D2-3 to D2-4 and thus to D3-2 where it is compared with the "desired" voltage on D3-3 (speed control).

The speed is high as long as the selected end microswitch is not actuated. When this microswitches is actuated a low is connected to either D4-1 or D4-6, this will be reflected on D1-1 or D1-2 causing a high on D2-10 switching D2-1 through to D2-15.

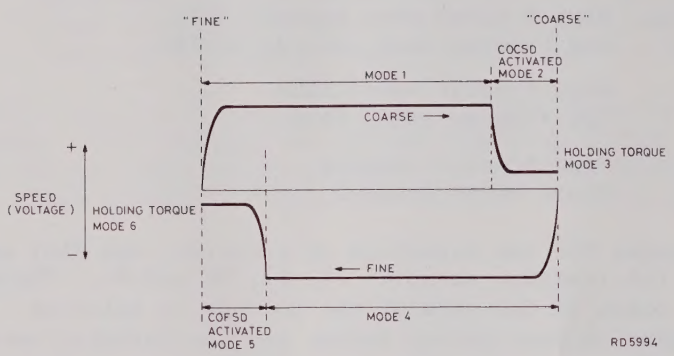

Figure B.

When the motor is at one of its end positions (mode 3 or 6) and there is a request for the opposite position, COLVF+ changes its state. This causes the voltage on COLMT+ (because D2-11 switches a different reference voltage through to D3-3) to change its polarity and increase in value. The motor then starts to run FAST (figure B, modes 1 or 4) towards the other end stop.

When the end position microswitch (either COFSD- or COCSD-) is actuated, the motor slows down because the speed setpoint changes (R5 and R3 are now connected in parallel). The collimator now runs smoothly towards its end stop (mode 2 or 5). When the collimator reaches its end stop the motor stops, and this is detected by D3-5 and 6, and mode 3 or 6 is entered. The correct status information is generated by D4.

The states (or voltage levels) of several parts of the circuit in the different modes is given in table 1. Some of the levels cannot be defined, and as such have been entered in the table as "-" or "+", where + indicates a positive level (++ meaning more positive) and - indicates a negative level (-- meaning more negative), x indicates a "don't care" state.

Table 1. Voltage levels and states

	Mode 1 Move fast to FINE	Mode 2 Move slowly to FINE	Mode 3 Stopped at FINE	Mode 4 Move fast to COARSE	Mode 5 Move slow to COARSE	Mode 6 Stopped at COARSE
COLVF+	HIGH	HIGH	HIGH	LOW	LOW	LOW
COFSD-	HIGH	LOW	LOW	x	x	x
COCSD-	x	x	x	HIGH	LOW	LOW
D3-2,3	+3,8 V	+5,45 V	+5,45 V	+8,2 V	+6,55 V	+6,55 V
COLMT+	- -	-	-2,6 V	+ +	+	+2,6 V
COLMT-	-	-	-1,3 V	+	+	+1,3 V
D3-7	-4,4 V	-1,1 V	0	+4,4 V	+1,1 V	0
D3-8	> +9 V	> +9 V	< -9 V	< -9 V	< -9 V	< -9 V
D3-14	< -9 V	< -9 V	< -9 V	> +9 V	> +9 V	< -9 V
D2-9	HIGH	HIGH	LOW	HIGH	HIGH	LOW

SPARE PARTS

Spare parts for the Control Board U1 are as follows:

Item	Description			Ordering Code
Capacitors				
C1 C2	40V	-20+80%	22nF	4822 122 30103
C3	250V	10%	47nF	5322 121 44138
C4	100V	10%	3,3nF	5322 121 40283
C5 C6	16V	20%	10uF	5322 124 14066
Integrated Circuits				
D1	HEF4093BD			5322 209 14927
D2	HEF4053BD			5322 209 10576
D3	LM324N			4822 209 80587
D4	HEF4071BD			5322 209 10307
Resistors				
R1, 11, 12, 14 15, 16, 20, 21, 22, 23	MR25	1%	10K	4822 116 51253
R2 R4	MR25	1%	13K3	5322 116 55276
R3	MR25	1%	15K4	5322 116 55459
R5	MR25	1%	3K32	4822 116 51247
R6	MR25	1%	100E	5322 116 55549
R7 R10	PR37	5%	6E8	4822 116 51876
R8	MR25	1%	20K5	5322 116 55419
R9	MR25	1%	6K81	4822 116 51252
R13	MR25	1%	42K2	5322 116 50474
R17	MR25	1%	16K2	5322 116 55361
R18	MR25	1%	2K05	5322 116 50664
Semiconductors				
V1	LF transistor		BD139	4822 130 40823
V2	LF transistor		BD140	4822 130 40824
V3 V4	Silicon Diode		BAW62	4822 130 30613

Power Supply Board A14

Resistor				
R121	MR25	1%	1K	4822 116 51235

For the Mechanical parts refer to the PW1404 Service Manual Chapter 10.

Figure 1.

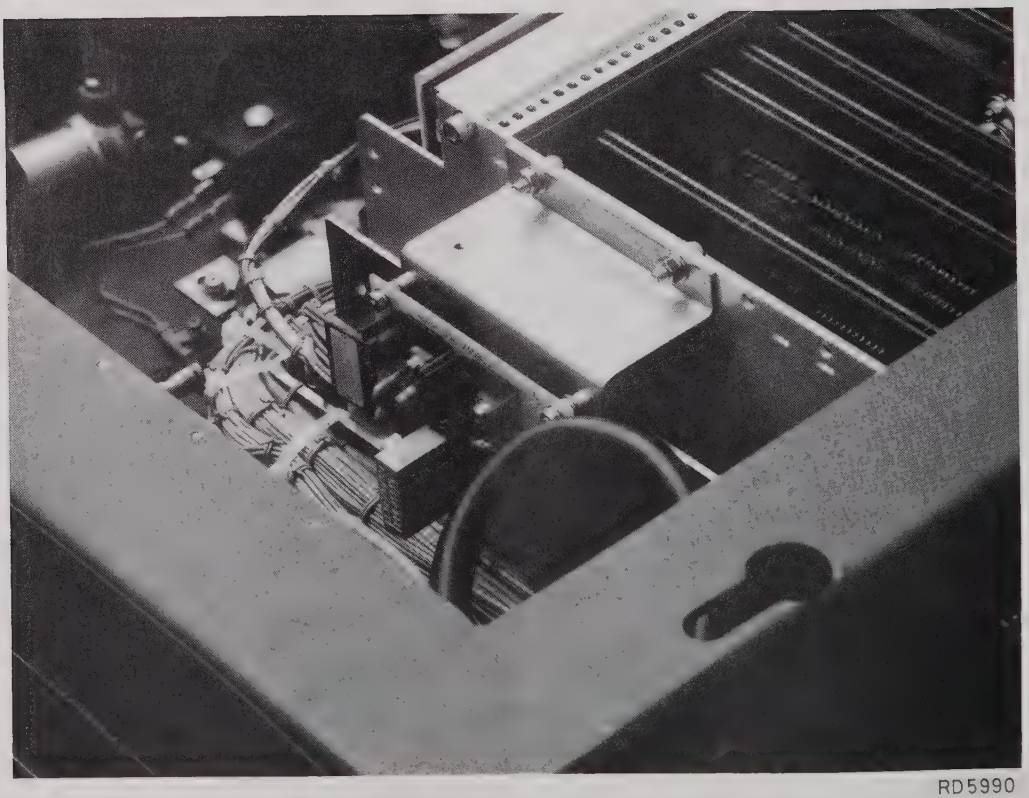

Figure 2.

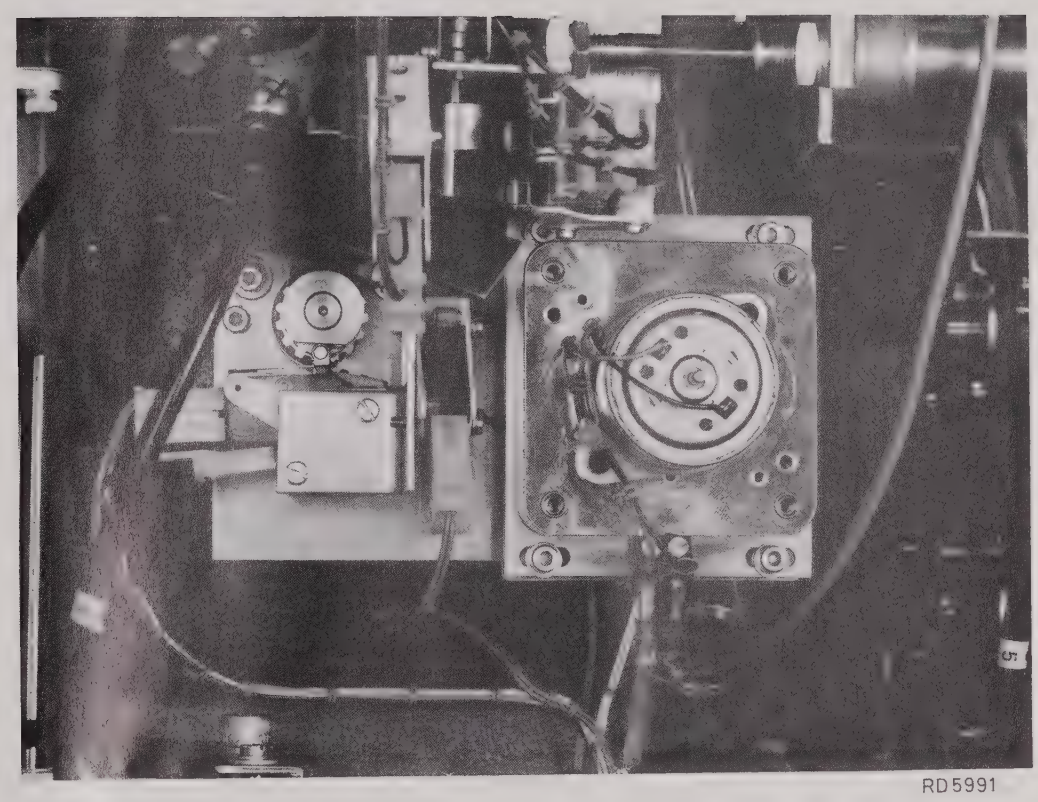

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Figure 3.

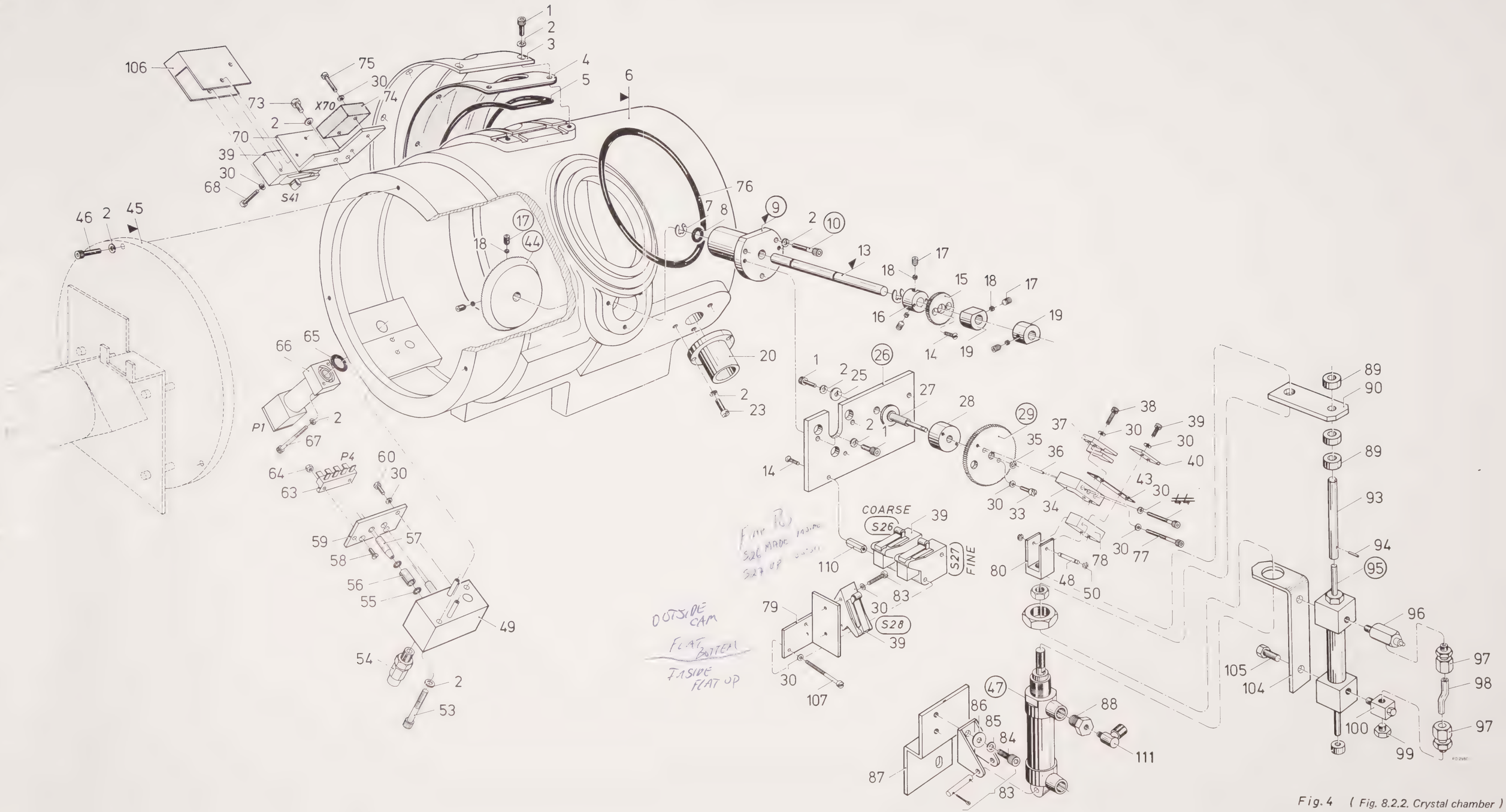

Fig. 4 (Fig. 8.2.2. Crystal chamber)

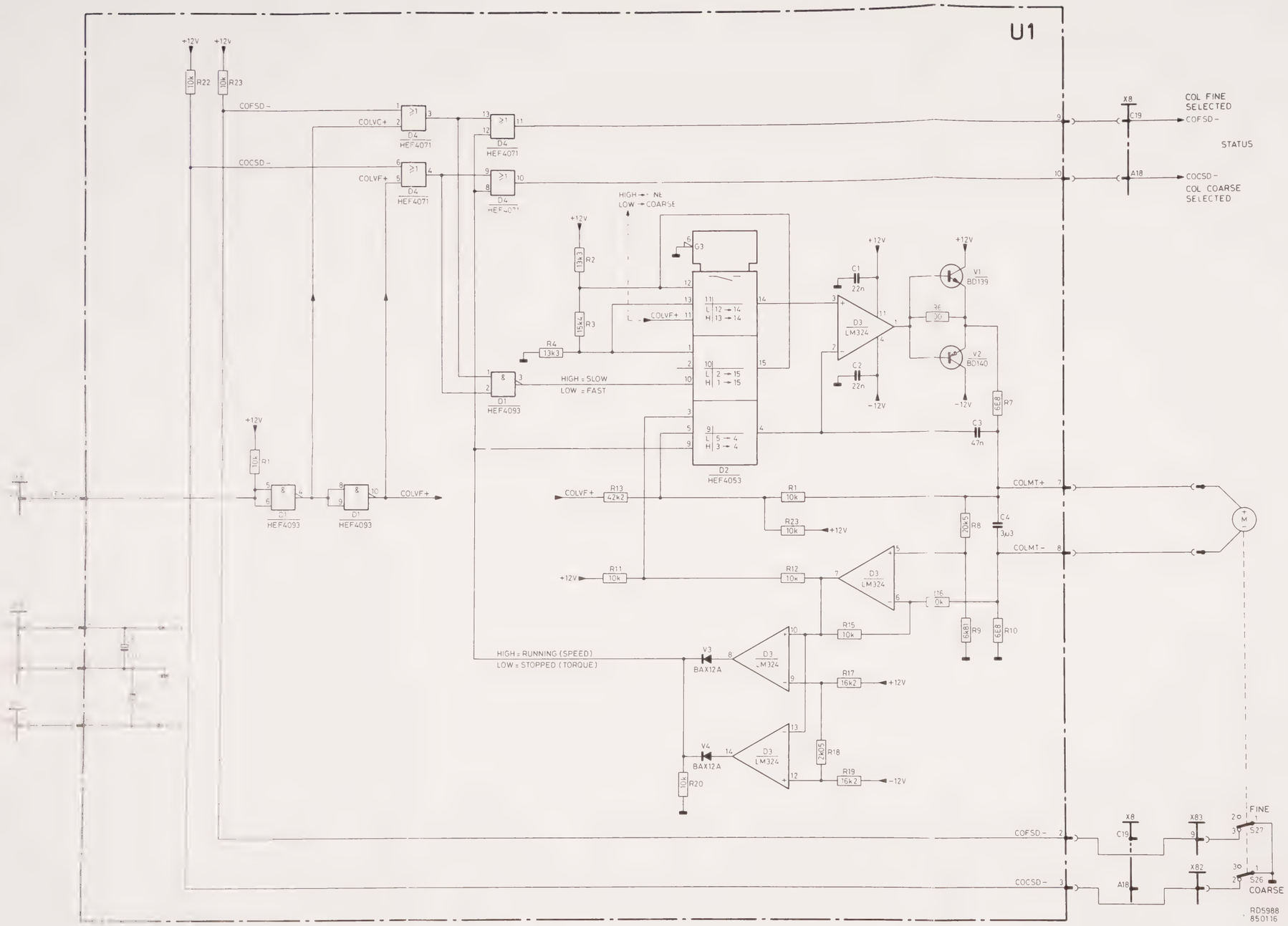
U1
+12V
R22 10k
R23 10k
COFSD –
COLVC+
COCSD –
COLVF+
D4 HEF4071
X8
C19
COL FINE SELECTED
COFSD –
STATUS
A18
COCSD –
COL COARSE SELECTED
HIGH = NL
LOW = COARSE
R2 13k3
R3 15k4
R4 13k3
G3
COLVF+
D1 HEF4093
HIGH = SLOW
LOW = FAST
D2 HEF4053
C1 22n
C2 22n
D3 LM324
V1 BD139
V2 BD140
R6 3Ω
R7 6E8
C3 47n
COLMT+
COLMT –
M
R1 10k
R13 42k2
R23 10k
+12V
R11 10k
R12 10k
R16 10k
R8 20k5
C4 3µ3
R9 6k81
R10 6E8
R15 10k
HIGH = RUNNING (SPEED)
LOW = STOPPED (TORQUE)
V3 BAX12A
R17 16k2
V4 BAX12A
R18 2k05
R19 16k2
R20 10k
–12V
X83
X82
S27
S26
FINE
COARSE
RD5988
850116

Figure 5

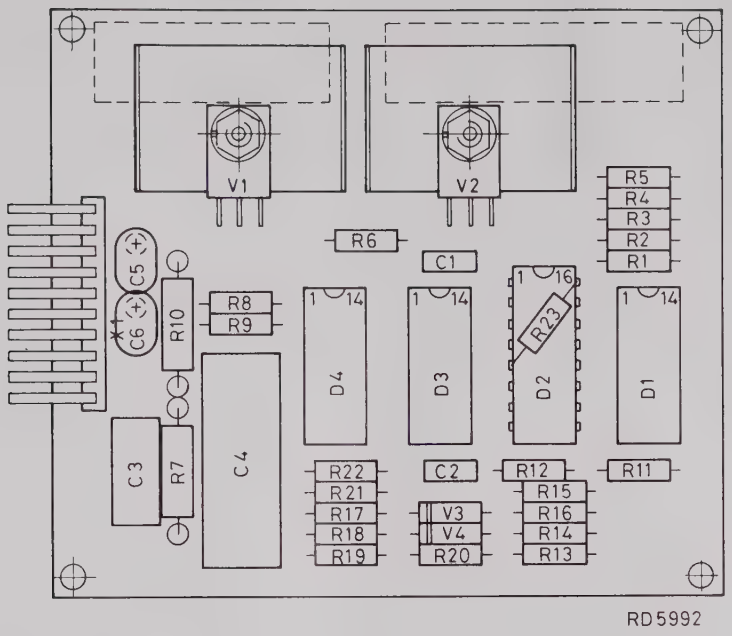

Figure 6

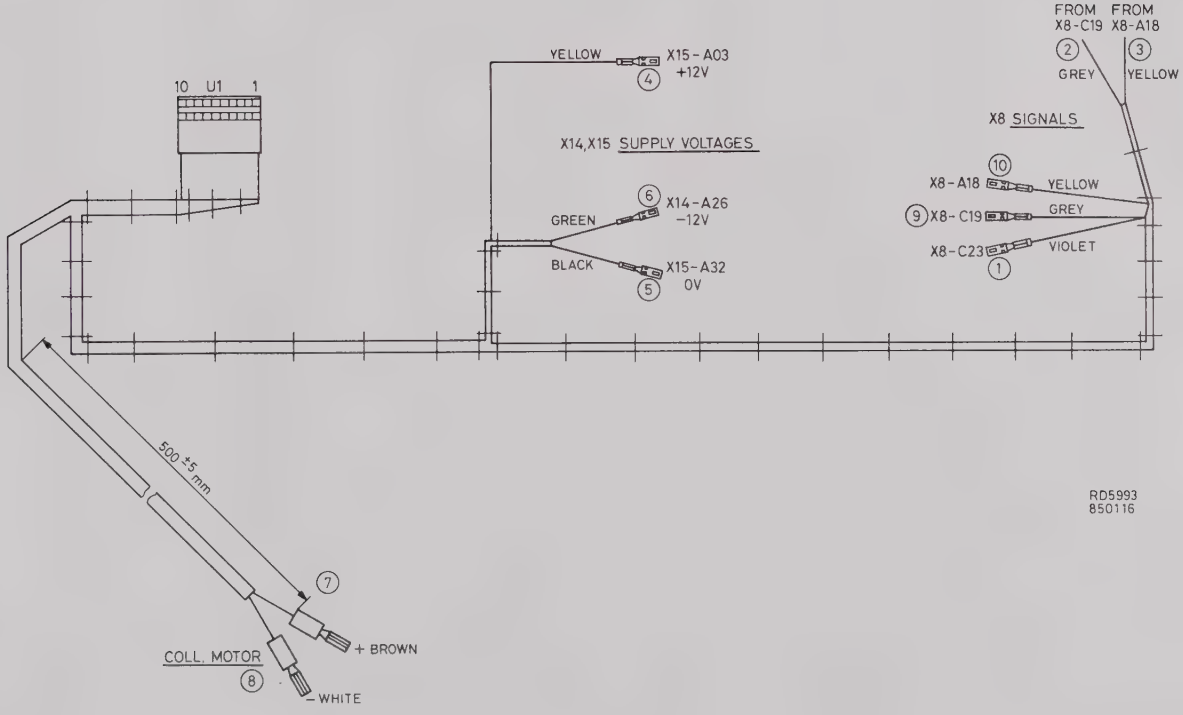

Figure 7

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equipment for science and industry

81 - 09 - 07 SPARES POLICY CONCERNING (P) ROM'S XRA-169

PW 1400/00, PW 1502/00/40 and PW 1600/10

Subject: *Already issued:*

PW 1400/00 – XRA 141, 142, 150, 153, 156, 157, 159, 161, 162, 164, 165, 167

PW 1600/10 – XRA 157, 159, 161, 162, 163, 164, 165, 167

1. **Supply center spare's policy concerning (P) ROM's.**

Basically the following policy has been accepted.

1.1 Only the latest version firmware of the (P) ROM's will be held in stock.

1.2 The complete CPU-boards held in stock will also have the latest version of the firmware.

1.3 Only two items of each (P) ROM will be held in stock at Concern Service as (P) ROM failure is rare.

1.4 When a new firmware version is issued the existing stock will be updated under the same ordering number.

1.5 Before ordering any item check that the firmware is the latest version as advised by the latest XRA-service information.

1.6 A complete update package can be supplied by the supply center only as instructed. Refer for contact address example below.

1.7 A note will be packed with every (P) ROM or complete CPU-board showing the version number of the firmware.

For example:

PW 1400/00 PROM "5"

This PROM 5322 694 14491 belongs to version 2.0 of the firmware for PW 1400/00 and must be identical to the version to be replaced.
It is for use with software packages:

- PW 1490/00 version 2.1 and later, used with the Philips P851 comp.
- PW 1490/4./5./7./ version 2.1 and later, used with the DEC PDP/.-comp.

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If the PROM version to be replaced is not the same as the delivered version the complete firmware must be ordered by the following action:

- Contact Mr. Bouwhuis, Logistics Department,
  Philips N.V. Lelyweg 1, 7602 EA Almelo.
  The Netherlands
- Advise the following:
  - System type and serial number, e.g. PW 1400/00, DY601.
  - Customers name and address.
  - Computer system, e.g. PW 1790/11, DEC PDP 11/04.
  - Software package, e.g. PW 1490/00, version 2.1
  - Sample changer in use, e.g. PW 1500/. ., Herzog-type.

- Ordering code for complete firmware version 2.0:
  9430 900 85051
- Ask for a return number in order to return the replaced PROMS and credit will be issued when the delivered PROMS are returned.

2. List of services codes.

2.1 Boards complete with firmware.

Description	Layout	Service code
CPU-board for PW 1400/00	Fig. 1+2	5322 694 14363
CPU-board for PW 1600/10	Fig. 1+2	5322 694 14422
PROM-board for PW 1502/00	Fig. 3	5322 694 14512
PROM-board for PW 1502/40	Fig. 3	5322 694 14513

Note:

The following PROM's are not intended to be used to update your complete firmware version. For complete update see 1.6.

2.2 PROM's with firmware for PW 1400/00.

PROM "0"	Fig. 1+2	5322 694 14487
PROM "1"	Fig. 1+2	5322 694 14486
PROM "2"	Fig. 1+2	5322 694 14485
PROM "3"	Fig. 1+2	5322 694 14484
PROM "4"	Fig. 1+2	5322 694 14492
PROM "5"	Fig. 1+2	5322 694 14491
PROM "6"	Fig. 1+2	5322 694 14489
PROM "7"	Fig. 1+2	5322 694 14488

2.3 PROM's with firmware for PW 1600/10.

PROM "1"	Fig. 1+2	5322 694 14523
PROM "2"	Fig. 1+2	5322 694 14524
PROM "3"	Fig. 1+2	5322 694 14525
PROM "4"	Fig. 1+2	5322 694 14526
PROM "5"	Fig. 1+2	5322 694 14527
PROM "6"	Fig. 1+2	5322 694 14528
PROM "7"	Fig. 1+2	5322 694 14529
PROM "8"	Fig. 1+2	5322 694 14531

2.4 PROM's with firmware for PW 1502/00.

PROM "8"	Fig. 3	5322 694 14515
PROM "9"	Fig. 3	5322 694 14516
PROM "10"	Fig. 3	5322 694 14517

2.5 PROM's with firmware for PW 1502/40.

PROM "8"	Fig. 3	5322 694 14518
PROM "9"	Fig. 3	5322 694 14519

2.6 Replaced PW 1400/00 code numbers.

In the PW 1400/00 Service Manual pages 8-36 and 8-38 change the exsisting code numbers to read as follows:

		Old code	New code
D1	PROM 2716 INDICATION 3	5322 209 14434	5322 694 14484
D2	PROM 2716 INDICATION 2	5322 209 14435	5322 694 14485
D3	PROM 2716 INDICATION 1	5322 209 14436	5322 694 14486
D4	PROM 2716 INDICATION 0	5322 209 14437	5322 694 14487
D5	PROM 2716 INDICATION 7	5322 209 14438	5322 694 14488
D6	PROM 2716 INDICATION 6	5322 209 14439	5322 694 14489
D7	PROM 2716 INDICATION 5	5322 209 54586	5322 694 14491
D8	PROM 2716 INDICATION 4	5322 209 54587	5322 694 14492

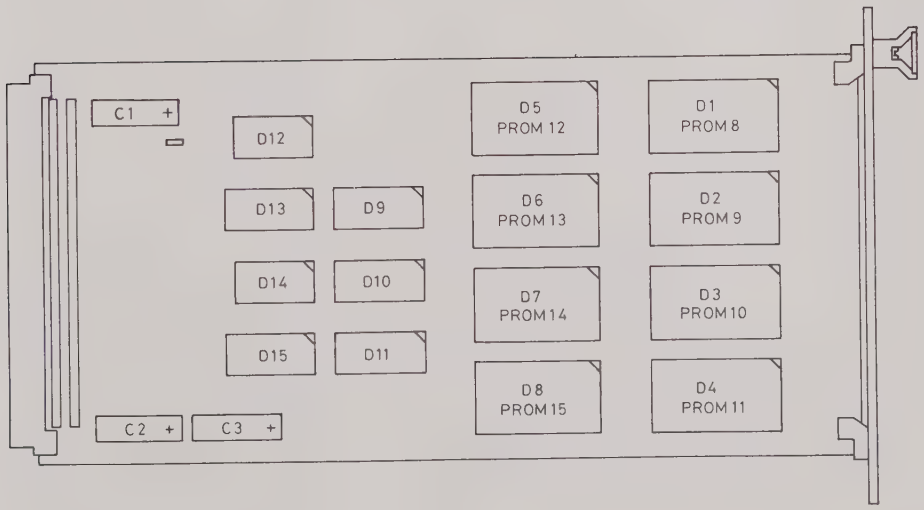


Figure 3. ROM-board layout

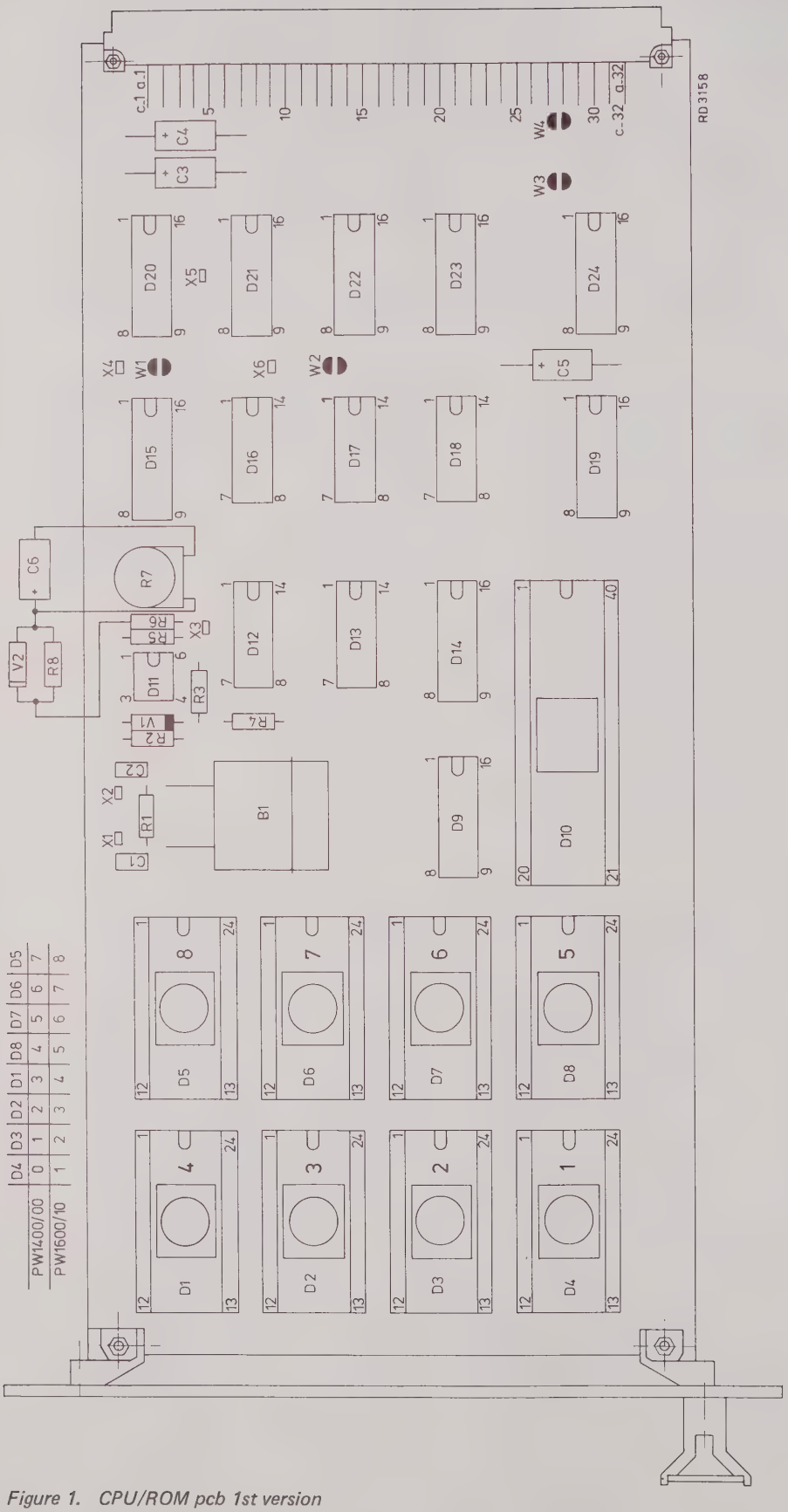
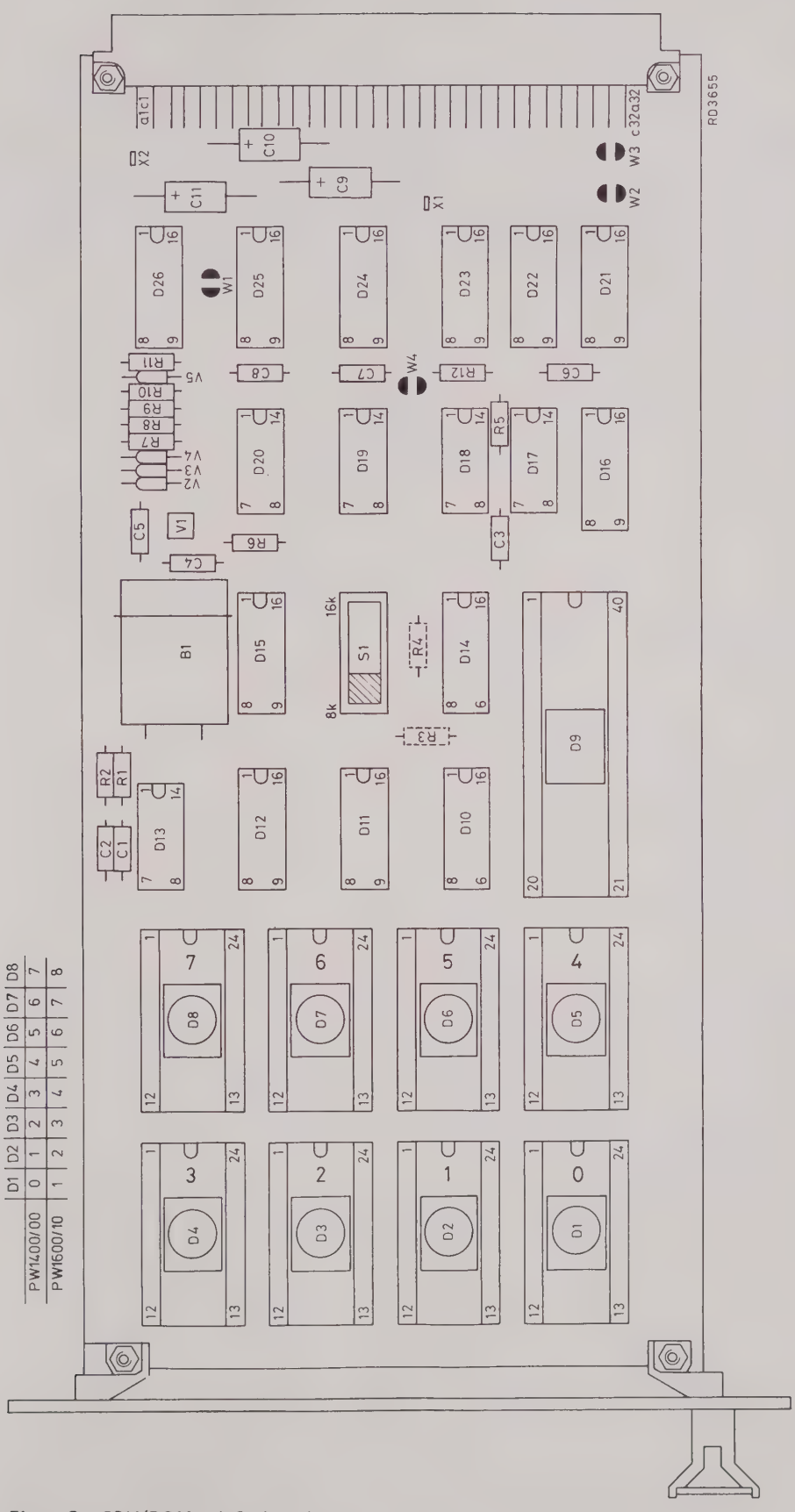


Figure 1. CPU/ROM pcb 1st version



	D1	D2	D3	D4	D5	D6	D7	D8
PW1400/00	0	1	2	3	4	5	6	7
PW1600/10	1	2	3	4	5	6	7	8

Figure 2. CPU/ROM pcb 2nd version

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810408 | PW1270/00/10/20/30 | XRA178

PW1400/00
PW1410/20/80/20
PW1450/00/10/60/70/80

Action: When the original vacuum pump must be renewed a conversion kit is required.

Already issued:

PW1270/00/10: N1, 2, XRA2, 6, 7, 8, 10, 28, 47, 54, 61, 62, 109, 136, 140.

PW1270/20 : XRA61, 62, 109, 136, 140.

PW1270/30 : XRA47, 62.

PW1400/00 : XRA141, 142, 150, 153, 157, 162, 167, 169.

PW1410/20/80: XRA56, 85, 95, 97, 103, 104, 105, 107, 109, 111, 113, 115, 117, 118, 123, 144.

PW1450/00/10/60/70: XRA3, 9, 11, 13, 15, 17, 21, 24, 27, 28, 33, 34, 36, 37, 41, 42, 46, 56, 60, 62, 63, 65, 80, 83, 86, 94, 100, 107, 109, 111, 123, 136, 140, 151, 170.

PW1450/20/80: XRA28, 55, 56, 60, 83, 85, 86, 94, 96, 100, 101, 104, 106, 107, 108, 109, 111, 112, 115, 123, 135, 136, 140, 151, 170.

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Conversion kit vor vacuum pump

Edwards vacuum pump type ES200 is no longer available.
It can be replaced by the Edwards replacement type E2M8. The order code for the pump has not been changed.
It is as follows:

5322 390 20033 for Edwards E2M8 type vacuum pump 50/60Hz.

Conversion kit ES200/E2M8 — ordering code 5322 694 14551.
This is a universal kit for PW1600/00/60, PW1450, PW1410, PW1400 and PW1270. The kit consists of:

1	mounting plate	1
4	distance pieces	2
4	distance pieces	3
4	allen screws M6x20 and spring washers	
18	nuts M8 and spring washers	
1	coupling flange SC25	8
2	hex screws	9
1	stepped O ring carrier 28mm/1 1/8	10
1	adaptor tube (for PW1410)	
1	tube (not for PW1600/00/60)	
4	clamps } transport clamps, only necessary if the spectrometer with the	
4	strips } new pump must be transported.	

Mounting can be done after the existing 4 shock absorbers have been removed, see fig. 1.

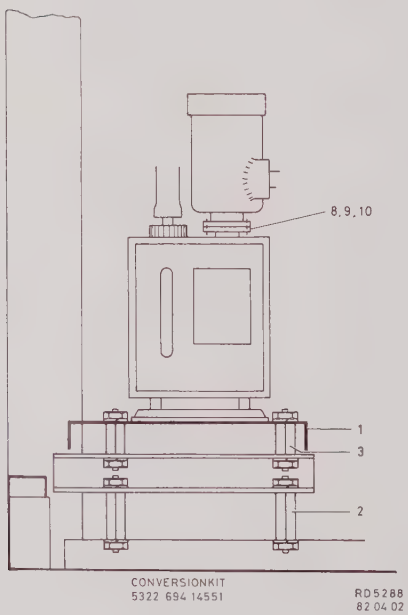

Fig. 1. New vacuum pump mounted with conversion kit 5322 694 14551

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Test & Measuring Instruments
Industrial Automation
Advanced Automation Systems
Welding

Scientific & Industrial Equipment Division

820409 PW1400/00 XRA179

Action:

1. Only required if optocouplers must be renewed on Generator Safety Control PCB.
2. Urgent. Required to prevent damage to X-ray tube which can be caused by failure of 12V power supply on spectrometer control 3 pcb. Incorporate this modification at the next available opportunity.

Already issued:

XRA141, 142, 150, 153, 156, 157, 159, 161, 162, 164, 167.

1. MODIFICATION TO GENERATOR SAFETY CONTROL PCB A39.

The optocoupler type CNY42 is no longer available and has been replaced in current production (starting with serial number DY901) by the optocoupler type CNY62.
This has resulted in a change to the values of the resistors R2, 4, 6, 8, 10, 12, 14, 15 (were 51k1 are now 10k), and the addition of the resistors R1, 3, 5, 7, 9, 11, 13, 16 (10k). The change in all these resistors is necessary to ensure proper operation of the relays in the generator.
See the attached modified pages 4-306, 8-56, and 8-57.

If it is necessary to renew the optocouplers CNY42, fit the type CNY62 and change the associated resistors as shown in the accompanying diagrams.

2. MODIFICATION TO SPECTROMETER CONTROL 3 PCB A10.

The components R7, R8, V1, and V2 have been added to the spectrometer control 3 pcb. This modification has been introduced to prevent the X-ray generator going into the 'remote' mode with the selection of maximum kV and mA if the 12V power supply fails.

This modification has been introduced into current production starting with serial number DY1001.

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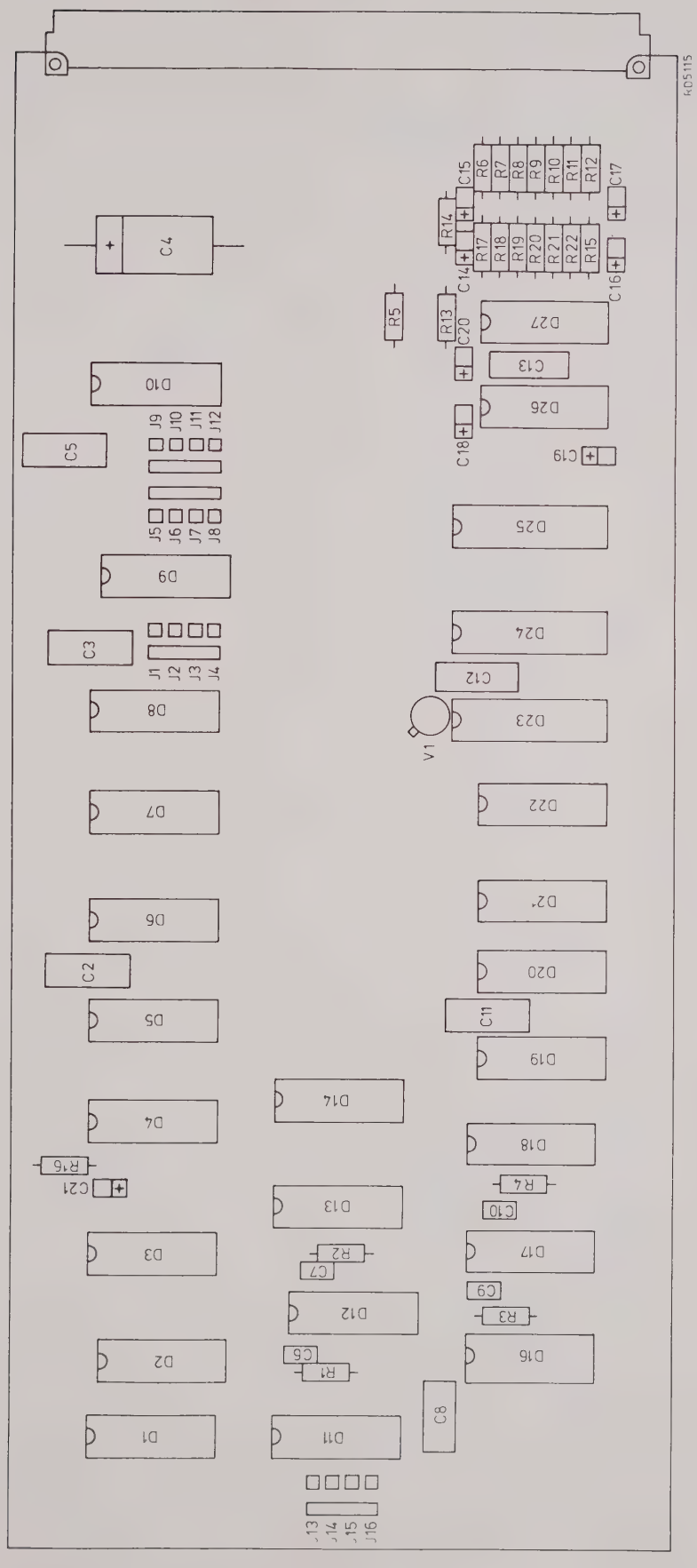


Fig. 8.1.9. Spectrometer control 2 pcb

8.1.10. Spectrometer control 3 pcb A10

	Factory code 4022 332 82390			Ordering code 5322 694 14339
Item	*Description*			*Ordering code*
Capacitors				
C1-7	68 nF	10%	250V	5322 121 41156
C8, 9	68 µF	−10 +50%	16V	5322 124 24136
Integrated circuits				
D2, 4, 14, 16	HEF40097BP			5322 209 14433
D6, 7	HEF40175BP			5322 209 14406
D8	HEF4069UBP			5322 209 14128
D9, 21	HEF4025BP			5322 209 14052
D10, 11	HEF4556BP			4822 209 10004
D18	HEF4071BP			5322 209 14053
D19	HEF4001BP			5322 209 14045
D20	HEF4013BP			5322 209 10002
D22	HEF40174BP			5322 209 14444
D23, 24	HEF4050BP			5322 209 14068
Resistors				
R1-6	11k	1%	MR25	5322 116 54623
R7	487E	1%	MR25	5322 116 55451
R8	1k	1%	MR25	5322 116 54549
Semi conductors				
V1	BC557			4822 130 44568
V2	BAW62			4822 130 30163

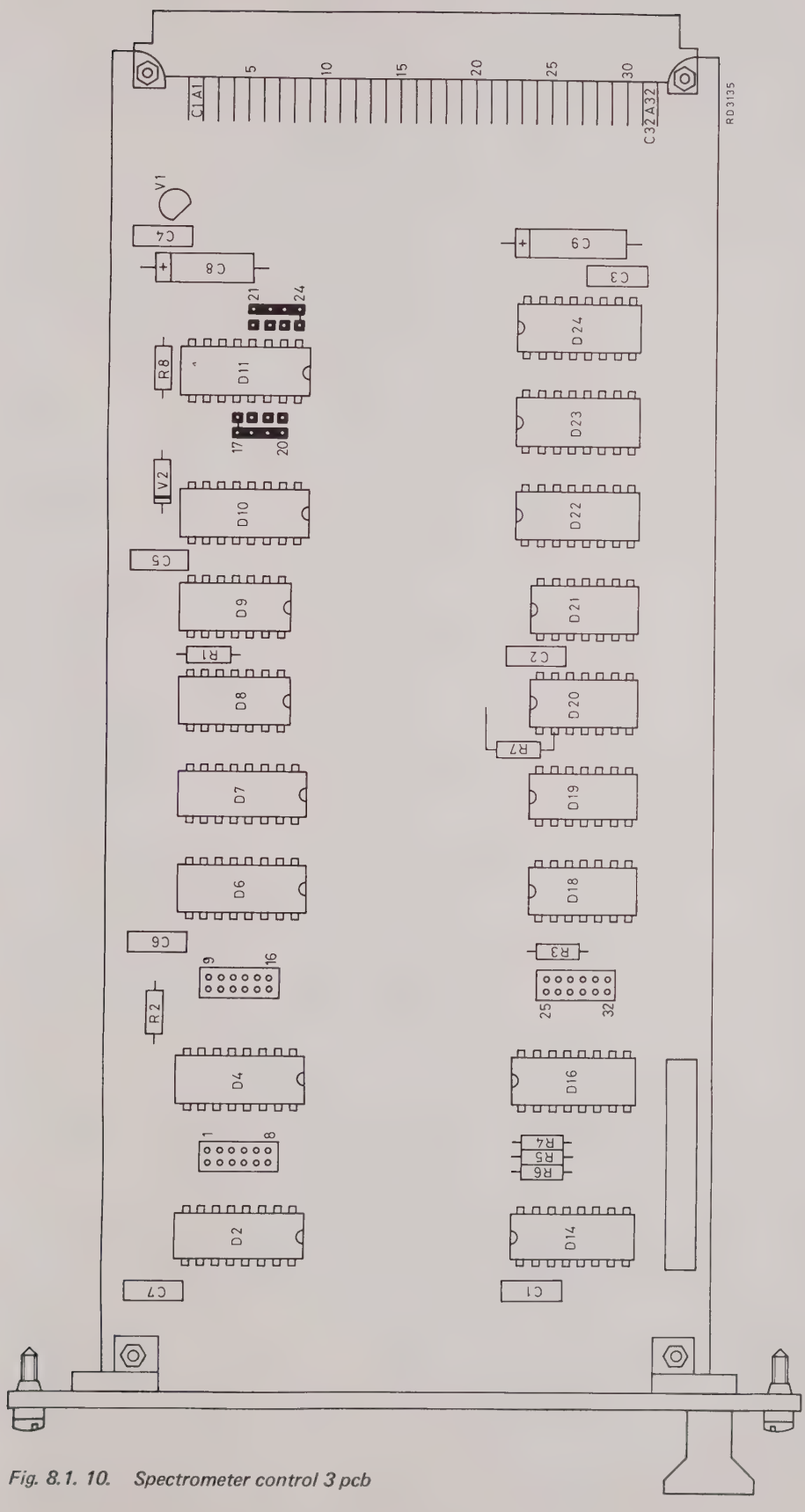


Fig. 8.1. 10. Spectrometer control 3 pcb

8.1.11. Bus interface pcb A15

Factory code 4022 332 82300 — Ordering code 5322 694 14341

Item	*Description*			*Ordering code*
Capacitors				
C1-8, 11-14, 17, 18	10 nF	−20 +80 %	40 V	4822 122 30043
C9, 10	68 µF	−10 +50 %	16 V	5322 124 24136
C15, 16	100 nF	10 %	100 V	5322 121 40323
Integrated circuits				
D1	LM324N			5322 209 85582
D2, 15, 17	HEF4011BP			5322 209 14046
D3	HEF4017BP			5322 209 14048
D4	HEF4071BP			5322 209 14053
D5, 6, 14	HEF4081BP			5322 209 14054
D7	HEF4556BP			4822 209 10004
D8	Voltage reg 7805CU			5322 209 85535
D9	HEF4082BP			5322 209 14213
D10	HEF4013BP			5322 209 10002
D11	HEF4049BP			5322 209 14049
D12, 13, 20, 23, 29	HEF4104BP			5322 209 14443
D16, 18, 25, 27	HEF40097BP			5322 209 14433
D19, 26, 28	HEF4050BP			5322 209 14068
D21	HEF4044BP			5322 130 44698
D22	4532PC			5322 209 85849
D24	Voltage reg 7905CU			5322 209 85836
Source				
G1	NiCD battery 41B021AD00501			2422 526 01032
Resistors				
R1, 7, 14, 18, 28-34	47 k	5 %	CR25	4822 110 63152
R2, 4-6, 12, 15-17, 26, 27	1 k	5 %	CR25	4822 110 63107
R3, 19, 21, 9	2k7	5 %	CR25	4822 110 63118
R10, 11, 35	10 k	5 %	CR25	4822 110 63134
R13, 22-25	270 E	5 %	CR25	4822 110 63092
R20	560 E	5 %	CR25	4822 110 63101
Diodes				
V1, 8, 9, 20, 22, 23, 6	BAW62			4822 130 30613
V3	BZX75-C1V4			4822 130 34047
V4	BZX79-C8V2			4822 130 34382
V5	BZX75-C2V1			5322 130 34049
V7, 18	BZX79-C6V8			5322 130 34278
V11	BZX75-C3V6			5322 130 30765
V13-17	LED CQY95			4822 130 30923
V19	BZX79-C12			4822 130 34197
Transistors				
V12	BC547			4822 130 44257
V21	BC557B			4822 130 44568

Item	*Description*	*Ordering code*
Transistors		
V1	BCY87	5322 130 40423
V2	BSV80	5322 130 34044
V3-5	BSS51	5322 130 44451
V6, 7	BD645	4822 130 41211
Diodes		
V8, 10	BAV21	4822 130 30842
V9	CQY95	4822 130 30923
V11-14		
Sockets		
X 1,2	Socket	5322 267 34074

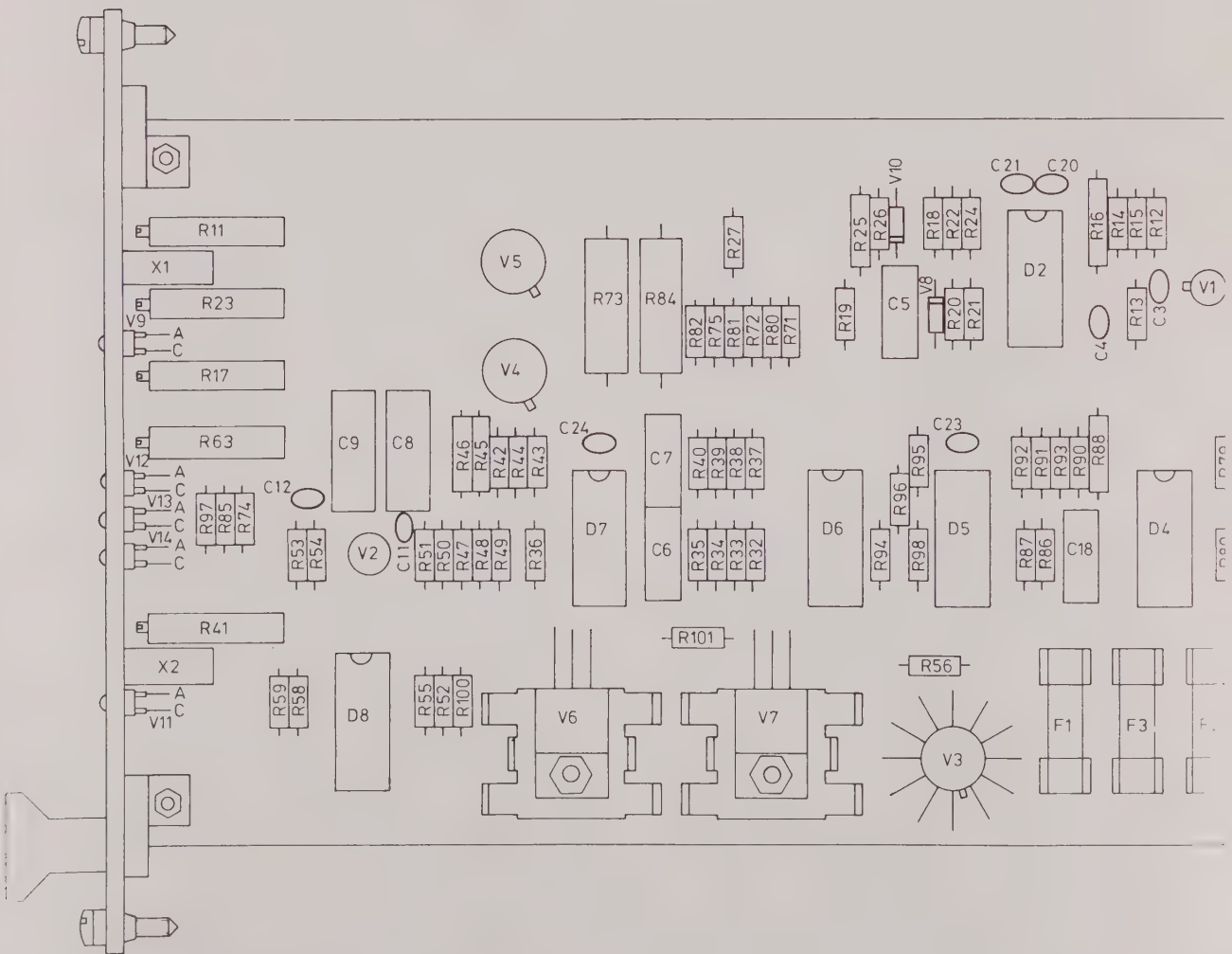
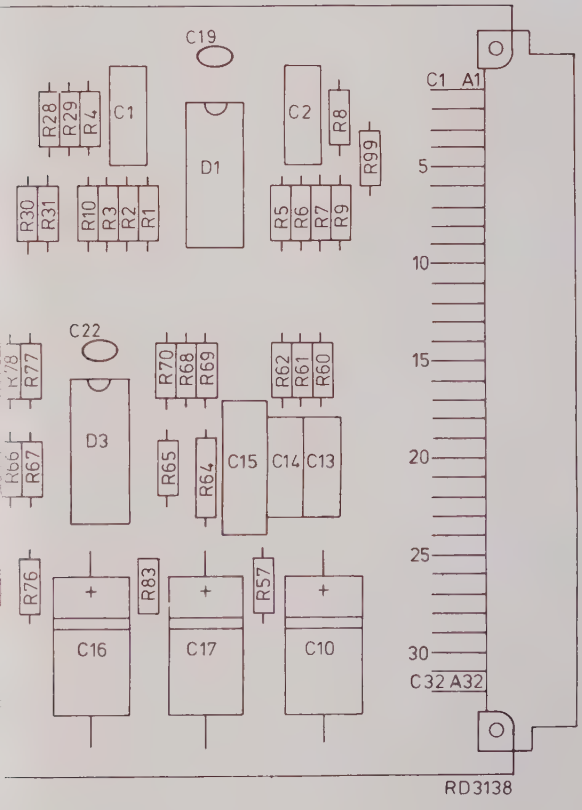


Fig. 8.1.19. Miscellaneous control pcb


C19
C1
C2
D1
R28
R29
R4
R8
R99
R30
R31
R10
R3
R2
R1
R5
R6
R7
R9
C22
D3
R70
R68
R69
R62
R61
R60
R77
R67
R65
R64
C15
C14
C13
R76
R83
R57
C16
C17
C10
C1 A1
5
10
15
20
25
30
C32 A32
RD3138

8.1.20. Generator control & safety pcb A39

	Factory code 4022 332 82590			Ordering code 5322 694 14345
Item	*Description*			*Ordering code*
Capacitors				
C2-4	10 μF	−10 +50%	63V	4822 124 20728
C5-8	1 μF	10%	100V	5322 121 40197
Integrated circuits				
D1-14	CNY62			5322 209 86029
D15, 16	HEF4050BP			5322 209 14068
D17	HEF4069UBP			5322 209 14128
D18	HEF4018BP			5322 209 14118
Relays				
K1-3	Relay PYE311-2C-24H			5322 280 24111
Resistors				
R20	22k	5%	CR25	4822 110 63143
R1-16	10k	1%	MR25	4822 116 51253
R19, 22, 24	100k	5%	CR25	4822 110 63161
R17, 21, 23	100E	5%	CR25	4822 110 63081
R40-43	10k	5%	CR25	4822 110 63134
R26	470E	5%	CR25	4822 110 63098
R27, 28	1k2	5%	CR25	4822 110 63109
R29-35	1k	5%	CR25	4822 110 63107
R36-39	56k	5%	CR25	4822 110 63154
R25	5k6	5%	CR25	4822 110 63127
Transistors				
V1, 3, 5, 7, 9, 11, 13, 15, 17	BSS51			5322 130 44451
V26	BC547			4822 130 44257
Diodes				
V19-25	BAW62			4822 130 30613

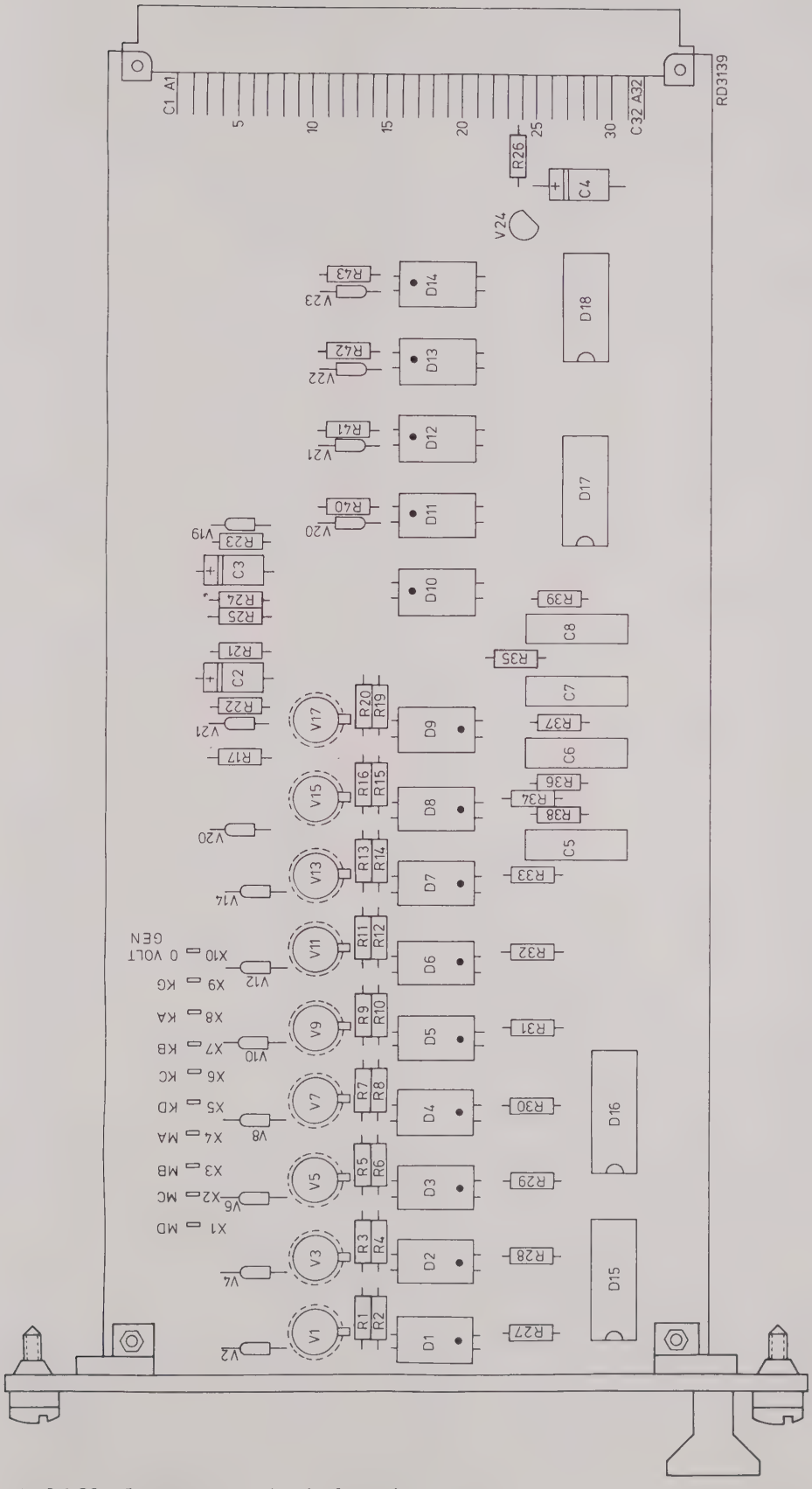


Fig. 8.1.20. Generator control and safety pcb

8.1.21. H.V. Supply, 1500 V, pcb A40

Factory code
4022 332 82540

Ordering code
5322 694 14346

Item	*Description*			*Ordering code*
C1	3,9 nF	10 %	100 V	4822 122 30098
C2	100 nF	10 %	100 V	5322 121 40323
C3, 4, 25, 26	220 nF	10 %	100 V	4822 121 40232
C5, 24	22 nF	–20 +80 %	40 V	4822 122 30103
C6, 16, 28	10 µF	–20 +20 %	16 V	5322 124 24089
C7	68 nF	10 %	1000 V	4822 121 40386
C9-11	68 nF	10 %	1600 V	4822 121 40179
C13	100 pF	2 %	100 V	4822 122 31081
C14	2,2 nF	–20 +80 %	40 V	4822 122 31116
C15, 17, 22, 23	10 nF	–20 +80 %	40 V	4822 122 30043
C18	22 nF	–20 +80 %	40 V	4822 122 30103
C19, 27	1 nF	–20 +80 %	40 V	4822 122 30027
C20	470 nF	10 %	100 V	5322 121 40175
C21	47 nF	10 %	100 V	5322 121 44138
Integrated circuits				
D1	NE555N			5322 209 85824
D2	HEF4017BP			5322 209 14048
D3, 4	LM208T			5322 209 85475
Resistors				
R1, 9	1 k	1 %	MR25	5322 116 54549
R2	2k2	20 %	0,05 W	4822 100 10029
R3	909 E	1 %	MR25	5322 116 54545
R4, 5, 7, 22	100 E	1 %	MR25	5322 116 54469
R6, 8	402 E	1 %	MR25	5322 116 54519
R10	1 E	5 %	CR25	4822 110 63027
R12	15 k	5 %	CR37	4822 110 53138
R13	820 E	5 %	4,2 W	4822 112 21105
R15	70 M	1 %	2 W	5322 116 54998
R16	348 k	0,5 %	MR34E	5322 116 55181
R17, 19	174 k	1 %	MR25	5322 117 54719
R18, 41	10 E	1 %	MR25	5322 116 50452
R20, 35, 36, 42	10 k	1 %	MR25	5322 116 54619
R21	226 E	1 %	MR25	5322 116 54497
R23	1 k	20 %	0,05 W	4822 100 10037
R24	15 M	5 %	VR37	4822 110 42218
R25	46k4	1 %	MR25	5322 116 50557
R26	100 k	20 %	0,05 W	4822 100 10052
R27, 29	100 k	1 %	MR25	5322 116 54696
R28, 30	1 M	1 %	MR20	5322 116 54188
R31	48k7	1 %	MR25	5322 116 50442
R32	10 k	0,5 %	MR24E	5322 116 50748
R33	32k4	0,5 %	MR24E	5322 116 55259
R34	1 k	0,5 %	MR24E	5322 116 50747
R38	3k65	0,5 %	MR24E	5322 116 54221
R39	12k4	0,1 %	MR24E	5322 116 55182
R40	499 E	1 %	MR25	5322 116 54524
R37	4k99	0,5 %	MR24E	5322 116 54057

MEMORY ADDRESS SELECTION

BYTE SELECTION

DISPLAY CONTROL

GENERATOR CONTROL

HT-GENERATOR SETTINGS

PW1730/..
HT_GENERATOR

SWITCHING ON - AND SAFETY CIRCUIT

FIG 4.4.5.3

ALPHA NUM DISPLAY

STATUS

NOTE : JUMPER SELECTION NOT USED IN PW1400/..

WINDOW CONTROL

SAMPLE UNDER THE CAP CIRCUIT

SWITCHING ON - AND SAFETY CIRCUIT

GALVANIC INSULATION

PLUNGER

CAP

TOP COVER

LOWER RIGHT HAND SIDE COVER

HT-CABLE

X-RAY TUBE

SAMPLE CHAMBER LEFT HAND SIDE

TOP COVER

FRONT COVER

UPPER REAR COVER

LOWER REAR COVER

AIR PRESSURE

SAFETY CIRCUIT

RD3374
82.04.06

Fig. 4.8.2. Spectrometer Control 3 circuit diagram

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820413 **SOFTWARE SURVEY No. 4** XRA180

PW1400/00, PW1600/10 AND APD15 (P851)

Subject:	Action required:
	Already issued:
	PW1400/00 – XRA141, 142, 150, 153, 156, 157, 161, 162, 164, 167, 169, 178, 179.
	PW1600/10 – XRA157, 161, 163, 164, 167, 169, 171, 172, 173, 177.
	APD15 – XRA175
1. Software XRF.	–
2. Software for XRD.	
3. PW1490/75/76. Functional differences beween versions 4.0 and 3.1 (RSX11-M).	Replace software
4. PW1690/00. Functional differences between versions 2.3. and 2.2. (FRTM)	Replace software
5. PW1690/75/76. Functional differences between versions 1.0 (RSX11-M) and 1.2. (RT-11)	New software
6. APD15 (P851) Functional differences between versions 3.0. and 1.0 (FRTM)	Replace software

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1. SOFTWARE FOR XRF

1.1. PW1490/.. SOFTWARE PACKAGE (X14)

CPU	Monitor	Medium	Version	Release date	Update number	Firm ware (μproc) prerequisites version	Remarks
/00 P851	FRTM	Single density disc	02.0	05-10-79	–	2.0	old
			02.1	10-03-80	9430 900 85001	2.0	old
			02.2	26-09-80	9430 900 85031	2.0	old
			02.3	30-01-81	9430 900 85111	2.0	new
/40 PDP11	RT11-SJ	Single density disc	03.0	15-08-80	9430 900 85021	2.0	old
			03.1	24-02-81	9430 900 85151	2.0	new
/41 PDP11	RT11-SJ	Double density disc	03.1	24-02-81	9430 900 85131	2.0	new
/45 PDP11	RT11-SJ	RL01 firm disc	03.0	09-10-80	–	2.0	old
			03.1	24-02-8	9430 900 85171	2.0	new
/50 PDT11	RT11-SJ	Single density disc	03.0	19-08-80	9430 900 85061	2.0	old
			03.1	24-02-81	9430 900 85181	2.0	new
/74 PDP11	RSX11-M	RK05 firm disc	No longer advised				
/75 PDP11	RSX11-M	RL01 firm disc	03.1	13-02-81	–	2.0	old
			04.0	15-12-81	9430 900 85471	2.0	new
/76 PDP11	RSX11-M	RL02 firm disc	04.0	15-12-81	9430 900 85481	2.0	new

1.2 PW 1690/.. SOFTWARE PACKAGE (X16)

C.P.U.	Monitor	Medium	Version	Release date	Update numbers	Firm ware (μ-proc) prerequisities version	Remarks
/00 P851	FRTM	Single density disc	02.0	23-05-80	–	2.1	old
			02.1	10-10-80	9430 900 85091	2.1	old
			02.2	15-01-81	9430 900 85121	2.1	old
			02.3	04-09-81	9430 900 85211	2.1	new
/40 PDP11	RT11-SJ	Single density disc	01.1	15-08-80	9430 900 85041	2.1	old
			01.2	24-02-81	9430 900 85161	2.1	new
/41 PDP11	RT11-SJ	Double density disc	01.2	24-02-81	9430 900 85141	2.1	new
/45 PDP11	RT11-SJ	RL01 firm disc	01.2	24-02-81	–	2.1	new
/50 PDT11	RT11-SJ	Single density disc	01.1	05-08-80	9430 900 85071	2.1	old
			01.2	24-02-81	9430 900 85191	2.1	new
/74 PDP11	RSX11-M	RK05 firm disc	No longer advised				
/75 PDP11	RSX11-M	RL01 firm disc	01.1	09-09-81	–	2.1	new
/76 PDP11	RSX11-M	RL02 firm disc	01.1	09-09-81	–	2.1	new

2. SOFTWARE FOR XRD

2.1. APD15 (P851) SOFTWARE PACKAGE

CPU	Monitor	Medium	Version	Release date	Update number	Firm ware (μ-proc) prerequisites version	Remarks
P851	FRTM	Single density disc	01.0	15-04-81	–	–	old
			03.0	02-10-81	9430 900 01201	–	new

2.2. PW1795/.. PW1700 SOFTWARE PACKAGE

CPU	Monitor	Medium	Version	Release date	Update number	Firm ware (μ-proc) prerequisites version	Remarks
/75 PDP11	RSX11-M	RL01 Firm disc	–	–	–	–	*
/76 PDP11	RSX11-M	RL02 Firm disc	–	–	–	–	*
/78 PDP11	RSX11-M	Mag. tape 800BPI	–	–	–	–	*

* Available 1982/83.

2.3. PW1890/.. JCPDS - FILE

CPU	Monitor	Medium	Version	Release date	Update number	Firm ware (μ-proc) prerequisites version	Remarks
/76 PDP11	RSX11-M	RL02 firm disc	–	–	–	–	*
/78 PDP11	RSX11-M	Mag. tape 800BPI	–	–	–	–	*

* Available 1982

3. PW1490/75

Functional differences between version 4.0 and 3.1 (RSX11-M).

3.1. The operators terminal must be a full duplex terminal.

3.2. If the spectrometer is busy and a command is partially typed in by the operator (so without <cr>, it will be aborted after 10-20 seconds, and the X14D package will show this with a ^U after the aborted command. This is necessary for organisational reasons.
The same procedure is valid for commands entered after the *MAN command has been given (commands for microprocessor).

3.3. Any command, unknown to the computer, will be sent to the microprocessor directly.

3.4. This version uses again the /M, /S, T or only / (all followed by a carriage return) sequences to stop certain actions, due to the inclusion of the full duplex terminal driver in the system.

3.5. Spooling has been introduced in the X14D package. The queue manager or the serial despooler can be used for output of data.

3.6. Extra system options have been added to the X14D package; the following options are defined:

1 Reserved
2 Reserved
3 For hardcopy question in regression program
4 For question "SAVE DATA IN DISK FILE" after concentration output
5 Reserved
6 Reserved
7 For adding data to the index file:

If this option is set, and the measurement type is SMX, the measured sample will be added to the index file

8 For spooling facilities:

A spooler file can be opened in two ways, depending on whether system option 8 is set or not:

a. If system option 8 is set: open the spooler file and if the file is not existing, create a sequential file with name XRFNSP, DMP. This file will be spooled automatically if the file is closed.
It can be spooled by giving the XRF command PSF.
b. If system option 8 is not set: open the file as a new file with the name XRFSPL, DMP. The file will automatically be spooled if it is closed.

3.7. An index file system is introduced in the X14D pakage.
If the measurement type is SMX and the WDD command has been given and the system option 7 has been set in the system parameter file with the aid of the ASP command, the following features of the samples written to the concentration data files, will also be written to the index file INDEXF, IND:

1. Record number in concentration data file
2. Record length of concentration data file
3. File name of concentration data file
4. Time and date at which the measurement was assembled
5. Sample identification

3.8. The regression analysis program is now a separate package on disc, which can be called by the command R14. The differences with the old version are indicated below.
To run the regression program, finish the X14 analysis program via the command END and type R14 after the prompt >.
The following points are changed with respect to the regression module in version 3.1 of the X14D-RSX11-M software:

a. The regression program accepts only the following commands: ASP, PSP, END, SRR, PMM, PCP, SRI, NRE, PRL, ISA DSA, CID, CCD, FAL, CAL, FBT, CBT, RCF, SRA, SRP, PLT and CEB.
b. The regression program is check-pointable if it is waiting for input from the operator. This means that if the system contains more than one terminal, the regression program may be run simultaneously from these terminals.
If the regression program must be used, it must be installed with the X14 command from the correct terminal.
c. The regression intensities and concentrations in the memory are only erased after the commands SRI and END.
d. If the operator types cntrl-Z, the regression program will stop (as after the END command). If cntrl-C is typed an RSX-MCR command can be given, but most MCR commands will not be executed because the operators terminal is attached in the regression program.
e. The program will not be aborted after RSX FORTRAN message 63 (the converted number does not fit into the output field. This is not only valid for the regression program, but also for the X14D package PW1400.
f. After the start of the program it will ask for the regression data file name. The same will happen after the command SRI. If no file name is given it is possible to input data via the operators keyboard.
g. After the command SRR, PMM and PCP the system will ask for the databank file name to be used in this command. The default name is the previously accepted databank name, or SYO: PW1400.DBK after the start of the program. The databank is not always in the memory in the regression program.
h. If the system parameters has indicated that a listing device 1 is not the operators terminal TT, and the operators terminal is a VDU (VT or GT) and a system option 3 has been selected, the system will first display the output of PMM, PCP, SRA and PRL commands on the VDU and then ask whether a copy should be made to listing device 1.
i. No data will be printed on the listing device after an error message from the SRA command. The error message will only be given on the operators terminal.

3.9. The commands ATI, PTI and DTI have been added.

ATI = Assemble tray identification file. In this file TRAYID.DAT, the identification of samples, which will be measured with the automatic sample changer, can be located.
At measuring time the tray/sample indication from the sample changer will be changed into the identification of the sample in the file, in case the sample is present in the file.
Moreover, if the LP list contains option 1 (input of concentrations of external elements), the concentrations will be asked for and saved in the file, as long as the user has indicated an MP number for the sample. The same applies to the normalising sum and/or initial- and final weight of diluted samples.
Once a sample has been measured, it is deleted from the file.

PTI = Print tray identification file.
If no argument has been given the tray numbers for which data exist in the file are printed. If a tray number is given as argument, the data for the samples in that tray will be printed.

DTI = Delete the data for a tray.

EXAMPLE OF THE OUTPUT FROM THESE COMMANDS

```
*  PTI
*** FILE DKO: TRAYID.DAT DOES NOT EXIST
*  ATI 55
TRAY NR= 55 :=
POSITION= 1   := 3
IDENT= SA3TR55
MPNR := 40                          (LP list 40 contains options 1,5 and 8)

GIVE CONCENTRATIONS:
D*       :  = 1.3
E*       :  =
F*       :  = .002
SUM      :  = 95.
INITIAL WEIGHT  := 10.
FINAL WEIGHT    := 8.

TRAY NR = 55 :=/

* PTI
IDENTIFIED TRAYS: 55

* PTI 55

TR   P  MP   IDENTIFICATION
55   3  40   SA3TR55              D* = 1.30  E*= .000  F* = .002 SUM= 95.0
                                  IWGT= 10.0 FWGT= 8.00

* DTI 55
*
```

3.10. Some errors have been corrected in this version:

1. The end-of-transmission characters were not printed at the end of the current printout, but at the start of the next printout.
2. The last part of a step scan in a job appeared too late on the printer.
3. Error 63 was generated and printed and as a result of that error the task X14D was sometimes aborted. It is only a warning that the result does not fit into the FORTRAN fieldwidth (****** is printed).
4. The last input of the CST command was transmitted to the microprocessor.

3.11. The DL11E vector- and external page address questions have been removed from the ASP command. There will only be asked if the spectrometer is on-line or off-line.
The DL11E addresses will be asked the first time the disc containing the X14D package will be booted. There will be built a spectrometer driver then, which contains certain features of the executive. This is necessary as the drivers tables are an implicit part of the executive.

3.12. Version 3.1.

As the X14D-RSX11-M version 3.1 is derived from the X14D-RT11 version 3.1 software package, the differences between X14D-RSX11-M version 3.1 and X14D-RT11 version 3.0 are given below.

1. With the Herzog sample changer, three digits will be printed behind TR... instead of two digits.
2. When asking for a file name, the measuring program number was destroyed when using the SPR or recalibration commands.
3. When giving the PLT command, an argument was asked for, but was not required.
4. Checking for the end of a databank is included.
5. The name of the package has been changed into X14D-RSX11-M v. 3.1.
6. Rearranging of CP-list changed. The old version used the common area RESULT to save temporarily the list to be moved to the end of the databank, thus overwriting the regression data. Moving now done with a help buffer.
7. The assignment to DX1 changed into SY1:
8. With the PCS command the files were always closed when checking of more MPnrs was asked for. This has been changed in order to make the PCS command more rapid.
9. The D- and E-indications were sometimes not correct when opening a recalibration file.
10. Various minor software amendments.
11. Systems option have been included in the ASP command.

3.13. Spooling facilities on PW1490/.. disc.

On the PW1490/.. disc delivered by PHILIPS the queue manager QMG task is present and can be used as a spooler. To use the queue manager on the PW1490/.. disc, for a terminal as spooling device, remove once with EDI in the startup file [1,2] STARTUP, CMD the .; before the statement @LBO:[1,2]QUESTART at the end of the indirect command file.
Therefore type the following commands:

```
> UIC 1,2
> EDI STARTUP, CMD
*PL QUEUESTART
*C /.://
*ED
:
```

As the queue manager has been built with default spooling device LP:, and the LP: driver has not been generated during the system generation process of the executive on the PW1490/.. disc, a terminal must be used as spooling device.

NOTE: A terminal, which is defined as spooling device, cannot be used anymore as an input device for an operator, because the queue manager will attach the terminal for its own use.

If the PW1490/.. disc is not used as system disc, the queue manager on a user generated system disc can also be used as spooling utility.

To use the spooler in the X14 package, define device SP as listing with the aid of the ASP command in the X14 package.

Example of the use of the spooler:

```
> RUN PW1400
>
X14D-004,0 RSX11-M
*** NO SYSTEM PARAMETERS ON SY0:
TERMINAL TYPE= PR :=
SYSTEM OPTIONS=  0 :=
CONCENTRATION AND LISTING OUTPUT DEVICES:
1 = TT   :=SP
WIDTH= 72 := /

* PMM
(The memory map will now be spooled on the spooling device, preceded by
 a form feed character)

* PSP
(The system parameters will now be spooled on the spooling device, preceded
 by a form feed character)

*ASP
TERMINAL TYPE= PR    :=
SYSTEM OPTIONS= 0    := 8
CONCENTRATION AND LISTING OUTPUT DEVICES :
1 = SP   :=  /

* PMM
(The memory map will now be saved on a file on disc and is not yet spooled)

* PSP
(The system parameters will now be saved in the same file on disc and not
 immediately spooled)

* PSF
(This commands spools the entire file on disc preceded by a single form feed
 and without other form feeds inside the file contents)

* END
>
```

3.14. Use of the X14D package

See "X14D - RSX11-M comments USEX14V4.0, DOC version 4.0"
A copy of which is sent with every software package
This information comprises:

- chapter 1 Block diagram X14D use
- chapter 2 Changements in new versions
- chapter 3 Spooling facilities on PW1490/.. disc
- chapter 4 Linkmaps X14D package
- chapter 5 System generation executive
- chapter 6 Layout of the startup file for X14D
- chapter 7 Copying X14 package to a user-generated system disc
- chapter 8 Executing the X14 package
- chapter 9 Adapting the DL11-E vector- and/or external page address
- chapter 10 Encounterering a problem in the X14 package
- chapter 11 Some advises on using the X14 package
- chapter 12 Indirect command files
- chapter 13 Special user-defined executive commands
- chapter 14 Error-messages and warnings
- chapter 15 Options in LP list

4. PW1690/00

Functional differences between versions 2.3 and 2.2. of X16 (FRTM)

4.1. If manual input of concentrations are given there is a check if the element has already been measured. If so, the manual concentrations must be skipped.
The comparison of manual concentration input element names was done with the calculated element names in a name list. This had to be done with the element names in another name list. As a result, sometimes elements for moduli or corrections were indicated as absent by the system.

4.2. If the SRI command was given, and a slash was given in reply to one of the first questions, the file was not closed and some of the element names in the disc file were destroyed after command ADC.

4.3. The length of the input buffer, declared in the Event Control Block, changed from 72 to 80 characters.

4.4. During input request the system hangs for some time in a loop in the keyboard function KBINPT and another input was not possible, because the SST (sent status) instruction was not accepted. Therefore, the SST is removed from the input routine.

4.5. The return flag for the keyboard (KBRETF) has been initialised, because an error occured if for the first time a SMX-measurement was started by means of a carriage return.

4.6. When the length of the parameter bank was such that only two trailing semicolons (;) terminate the output following the DPB command, the error message; "*** FILE IS NOT A PARAMETER BANK" was given after the RPB command.

4.7. If 10 alphas were given, a DO-loop was run one time too much. As a result it was not possible to calculate 10 alphas (the maximum is 10).

4.8. If STM command was given when both first and second output devices were in the ASP-command TT, and second output device was also the console, the samples were printed twice after the print commands.

4.9. After regression when the results are stored in a CP-list by the command SRR, the length of the list and the length of the databank may not be correct. This will happen when the CP-set already exists, and the number of fixed alphas, stored from the regression, is different to the number existing in the CP-set. Because of this error, a CP-list assembled in the above manner can generate ERROR 46, therefore, the CP-list should be deleted before regression.

Example of the use of the spooler:

```
> RUN PW1400
>
X14D-004,0 RSX11-M
*** NO SYSTEM PARAMETERS ON SY0:
TERMINAL TYPE= PR :=
SYSTEM OPTIONS= 0 :=
CONCENTRATION AND LISTING OUTPUT DEVICES:
1 = TT  :=SP
WIDTH= 72 := /

* PMM
(The memory map will now be spooled on the spooling device, preceded by
 a form feed character)

* PSP
(The system parameters will now be spooled on the spooling device, preceded
 by a form feed character)

*ASP
TERMINAL TYPE= PR   :=
SYSTEM OPTIONS= 0   := 8
CONCENTRATION AND LISTING OUTPUT DEVICES :
1 = SP  :=  /

* PMM
(The memory map will now be saved on a file on disc and is not yet spooled)

* PSP
(The system parameters will now be saved in the same file on disc and not
 immediately spooled)

* PSF
(This commands spools the entire file on disc preceded by a single form feed
 and without other form feeds inside the file contents)

* END
>
```

3.14. Use of the X14D package

See "X14D - RSX11-M comments USEX14V4.0, DOC version 4.0"
A copy of which is sent with every software package
This information comprises:

- chapter 1 Block diagram X14D use
- chapter 2 Changements in new versions
- chapter 3 Spooling facilities on PW1490/.. disc
- chapter 4 Linkmaps X14D package
- chapter 5 System generation executive
- chapter 6 Layout of the startup file for X14D
- chapter 7 Copying X14 package to a user-generated system disc
- chapter 8 Executing the X14 package
- chapter 9 Adapting the DL11-E vector- and/or external page address
- chapter 10 Encounterering a problem in the X14 package
- chapter 11 Some advises on using the X14 package
- chapter 12 Indirect command files
- chapter 13 Special user-defined executive commands
- chapter 14 Error-messages and warnings
- chapter 15 Options in LP list

4. PW1690/00

Functional differences between versions 2.3 and 2.2. of X16 (FRTM)

4.1. If manual input of concentrations are given there is a check if the element has already been measured. If so, the manual concentrations must be skipped.
The comparison of manual concentration input element names was done with the calculated element names in a name list. This had to be done with the element names in another name list. As a result, sometimes elements for moduli or corrections were indicated as absent by the system.

4.2. If the SRI command was given, and a slash was given in reply to one of the first questions, the file was not closed and some of the element names in the disc file were destroyed after command ADC.

4.3. The length of the input buffer, declared in the Event Control Block, changed from 72 to 80 characters.

4.4. During input request the system hangs for some time in a loop in the keyboard function KBINPT and another input was not possible, because the SST (sent status) instruction was not accepted. Therefore, the SST is removed from the input routine.

4.5. The return flag for the keyboard (KBRETF) has been initialised, because an error occured if for the first time a SMX-measurement was started by means of a carriage return.

4.6. When the length of the parameter bank was such that only two trailing semicolons (;) terminate the output following the DPB command, the error message; "*** FILE IS NOT A PARAMETER BANK" was given after the RPB command.

4.7. If 10 alphas were given, a DO-loop was run one time too much. As a result it was not possible to calculate 10 alphas (the maximum is 10).

4.8. If STM command was given when both first and second output devices were in the ASP-command TT, and second output device was also the console, the samples were printed twice after the print commands.

4.9. After regression when the results are stored in a CP-list by the command SRR, the length of the list and the length of the databank may not be correct. This will happen when the CP-set already exists, and the number of fixed alphas, stored from the regression, is different to the number existing in the CP-set. Because of this error, a CP-list assembled in the above manner can generate ERROR 46, therefore, the CP-list should be deleted before regression.

5. PW1690/75/76

Functional differences between versions 1.0 (RSX11-M) and RT-11)

5.1. Spooling has been introduced in the X16D. The queue manager or the serial despooler can be used for the output of data.
On the PW1690/75/76 disc delivered by Philips the serial despooler task PRT... is present and can be used as spooler.
The LP: line printer device has been assigned to it as spooling device.
In case a line printer LP: is not present in the users configuration, a terminal can be assigned as the spooling device; in that case after the disc has been booted and the user has logged in, type: REA PRT...3 TTxx:, in which xx is the terminal/number of the spooling terminal.
The queue manager on a user generated system disc can also be used as spooling utility.
To use the spooler in the X16 package, define device SP as listing device with the aid of the ASP command in the X16.

5.2. Extra system options have been added to the X16D package; the following system options are defined:

1 Reserved
2 Reserved
3 For hard copy question in concentration print program
4 For question "SAVE DATA IN DISK FILE" after concentration output
5 Reserved
6 Reserved
7 For adding data to the index file:
If this option is set, and the measurement type is SMX, the measured sample will be added to the index file.
8 For spooling facilities:
A spooler file can be opened in two ways, depending on whether system option 8 is set or not:

a. If system option 8 is set: open the spooler file and if the file is not existing, create a sequential file with name XRFNSP.DMP. This file will not be spooled automatically if the file is closed. It can be spooled by giving the XRF command PSF.

b. If system option 8 is not set: open the file as a new file with the name XRFSPL.DMP. The file will be automatically be spooled if it is closed.

To use the spooler in the X16 package, define device SP as listing device with the aid of the ASP command.

5.3. The CP list will no longer be present in the databank, but they will be located on disk as files with the extension Pxx, in which xx is the CP list number. This reduces the amount of space needed in the databank for lists.

5.4. An index file system is introduced in the X16D package.
If the measurement type is SMX and the WDD command has been given and the system option 7 has been set in the system parameter file with the aid of the ASP command, the following features of the samples written to the concentration data files will also be written to the index file:

1. Record number in concentration data file
2. Record length of concentration data file
3. File name of concentration data file
4. Time and date at which the data was assembled
5. Sample identification

A task RDINDX is located on the PW1690/75/76 disc as an example on how to process the parameters of the index file.
This task can be modified to fit the user requirements. For further information, see the source module RDINDX.FTN. which is present on the disc under UIC [202,14].

5.5. The regression analysis program is now a separate package on disc, which can be called by the command REG.

5.6. The common event flags 55 and 56 are used to synchronize the two tasks PW1600 and IOPAG1600 of the X16 package.

5.7. Use of the X16D package.

See "X16D-RSX11-M comments version 1.0" a copy of which is sent with every software package.
This information comprises:

- chapter 1 Block diagram X16D use
- chapter 2 Changements in new versions
- chapter 3 Spooling facilities on PW1690/.. disc
- chapter 4 Linkmaps X16D package
- chapter 5 System generation executive
- chapter 6 Layout of the startup file for X16D
- chapter 7 Copying X16 package to a user-generated system disc
- chapter 8 Executing the X16 package
- chapter 9 Abortion of the X16 package by the executive
- chapter 10 Changing the DL11-E vector- and/or external page address
- chapter 11 Encountering a problem in the X16 package
- chapter 12 Some advises on using the X16 package
- chapter 13 Indirect command files
- chapter 14 Special user-defined executive commands

6. APD15 (P851)

Functional differences between versions 3.0 and 1.0 (FRTM)

6.1. PW1780 sample changer software has been added.

6.2. Answers to question
MAXSCH =
in ASP command can now be 0,21, 35, 42,
if 35; sample changer PW1170 is assumed,
if 21 or 42; sample changer PW1780 is assumed and the commands: LPS – Load priority sample and
UPS – Unload priority sample are allowed.

6.3. The sample changer PW1780 must stay in the remote mode between measurements and, therefore, new commands have been added.
AUT – sets remote mode
MAN – sets manual mode

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Industrial Automation
Advanced Automation Systems
Welding

Scientific & Industrial Equipment Division

820409 | PW1400/00 | XRA183

Action:

1. Substitute new radiation 'Y' shield on the sample turret if poor reproducibility occurs between sample positions.
2. A new hose coupling has been included in the parts delivered with the spectrometer. Note this in the manual.
3. A modified valve has been introduced to control the water flow to the two coolers. If the original valve suffers from corrosion, substitute the new type.

Already issued:

XRA141, 142, 150, 153, 156, 157, 159, 161, 162, 164, 167, 179.

1. All spectrometers with serial numbers up to, and including DY950 have, mounted on the sample turret, a 'Y'-shaped radiation shield made of a mild-steel/lead sandwich, and it is possible in certain circumstances for the steel portion to become magnetized. This gives rise to an unacceptable difference in countrate between position 3 and the other positions in the sample turret— in this position the magnetic field of the shield affects the electron beam in the X-ray tube differently than in the other three positions, causing it to strike the anode in a slightly different place.

For those particular spectrometers where the radiation shield has become magnetized the solution is to fit a new shield made from a non-magnetic stainless steel/lead sandwich.
A new radiation shield can be obtained free- of- charge by ordering:

Radiation shield 4022 188 23400

and stating the serial number (DY...) of the spectrometer from:

Mr. H. Rotman
Logistics Department
S & I Division
N.V. Philips' Gloeilampenfabrieken
Lelyweg 1
7602 EA Almelo
The Netherlands

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2. Starting with serial number DY951, a new hose coupling has been added to the parts delivered with the spectrometer. This coupling is intended to enable an Altas compressor to be connected to the spectrometer.

Add the following information to page 8-89c of the service manual

Item	Qty	Description	Factory code number	Service code number
130	1	Hose coupling BUI DR10x1/4	8122 964 62120	5322 526 40383

3. Starting with serial number DY951, a new type of magnetic valve has been fitted in the water valve unit (see page 8-144). This valve has the same dimensions as the original type but is of a different internal construction and materials so that it has a higher corrosion resistance.

The service stock in concern service in Eindhoven has been changed to the new type, but the ordering code 5322 360 54064 remains unchanged.

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Scientific & Industrial Equipment Division

821223 | **PW1500/00/05/06/10/15/16** | XRA195

Already issued: XRA161

Action required:

1. Distance strip in grab mechanism.
   – Retrofit only if it is impossible to align the "Sample under cap" emitter and receiver so that light from the emitter is not reflected from the underside of the grab arm onto the receiver.
2. New emitter and receiver to detect the presence of a sample in the pick up position.
   – Retrofit only if ambient light conditions cause faulty detector signals.
3. New 50Hz and 60Hz motors.
   – Retrofit only if the universal 50/60Hz motor gives problems.
4. Additional support for top platform.
   – Retrofit only if belt tension of drive motor caused distortion of platform resulting in vibration of the sample trays.
5. New microswitch.
   – Retrofit only if the existing microswitch fails to operate correctly.
6. New "Sample under cap" detector.
   – Retrofit not required.
7. Insert the relevant accompanying pages in the PW1400/00 (Second Edition) and PW1600/10 Service Manuals as appropriate, and the remaining pages with the other XRAs.

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1. Distance strip in grab mechanism

In certain circumstances it is possible that the light beam from the "sample under cap" detector system can be reflected into the receiver via the underside of the grab mechnism. This occasionally has the effect that when a sample holder is loaded into the spectrometer, interrupting the direct light beam, the "sample under cap" signal is not produced because of this reflection.
To ensure that light cannot be reflected in this way, a distance strip can be fitted between the grab arm and the grab mechanism. This has the effect of lowering the grab mechanism sufficiently to block any light passing over the top of the sample holder, thus preventing reflection.
This strip has been fitted in production units as follows:

PW1500/05/06 starting with serial number DY661
PW1500/15/16 starting with serial number DY741

If a retrofit is essential, the strip can be ordered free of charge from S&I Almelo, with the code number 4022 332 34780, see "Ordering Procedure" at the end of this service bulletin.

Fit the strip as shown in the drawing, Fig. 8.5.6. (PW1400/00) or Fig. 9.2K (PW1600/10).
Two of the four existing M3 x 6mm screws must be replace with M3 x 8 mm screws.

Documentation changes:

In the PW1400/00 Service manual, replace page 8-165a with the replacement page 8-165a attached.

In the PW1600/10 Service manual; replace page 9-60 with the replacement page 9-60 attached.

8.5.6. Grab arm mechanism (common to both PW1500/00 and PW1500/10)

Item	Description	Ordering code
23-26	Grab arm slot pin (complete)	5322 535 74563
29	Sleeve bearing	5322 520 34173
24	Ball bearing single row sealed 5 x 16 x 5	5322 520 20122
26	Circlip 3.2 mm external	4822 530 70123
28	Ball bearing single row sealed 25 x 47 x 12	5322 520 24184
15	Slotted belville washer A8 SS 18	5322 530 84098
18	Cam	5322 466 85747
46	Self-aligning rod-end bearing M5	5322 520 14276
37	Clamp	5322 532 34112
43	Special bolt	5322 500 14246
67, 56 ... 60, 63	Grab assembly	5322 693 14011
80	Locking slide Cannon DB51221	5322 268 94008
M4	Synchronous motor 24V 50Hz	5322 361 84212
	Synchronous motor 24V 60Hz	5322 361 20381
M5	Synchronous motor 24V 50Hz	5322 361 20377
	Synchronous motor 24V 60Hz	5322 361 20379
S1-6	Microswitch assembly	5322 271 34064
X4B	Connector block 6-p	5322 290 64152
X4A	Contact block 25-pole pin Amp 20S208-1	5322 265 54044
	Contact pin AMP 66509-9	5322 268 14133

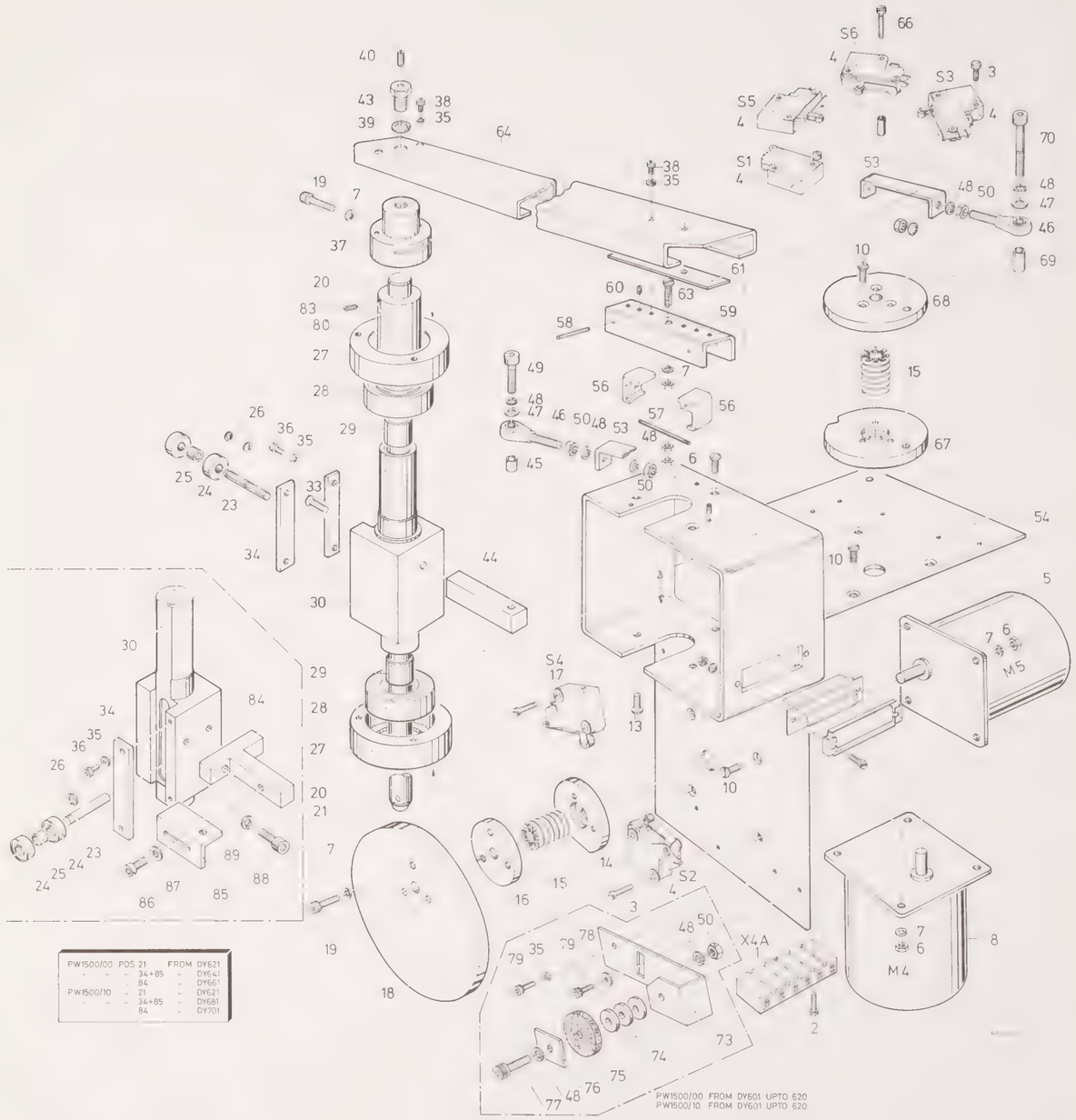

Figure 8.5.6. Grab arm mechanism

8.5.7. PW1500/00 sample loader mechanism

Item	Description	Ordering code
M1	Motor	5322 361 84211
S11, S15	Microswitch assembly 82790	5322 271 34194
S17, S19	Microswitch assembly	5322 271 34064
49	Lamp	5322 134 40146

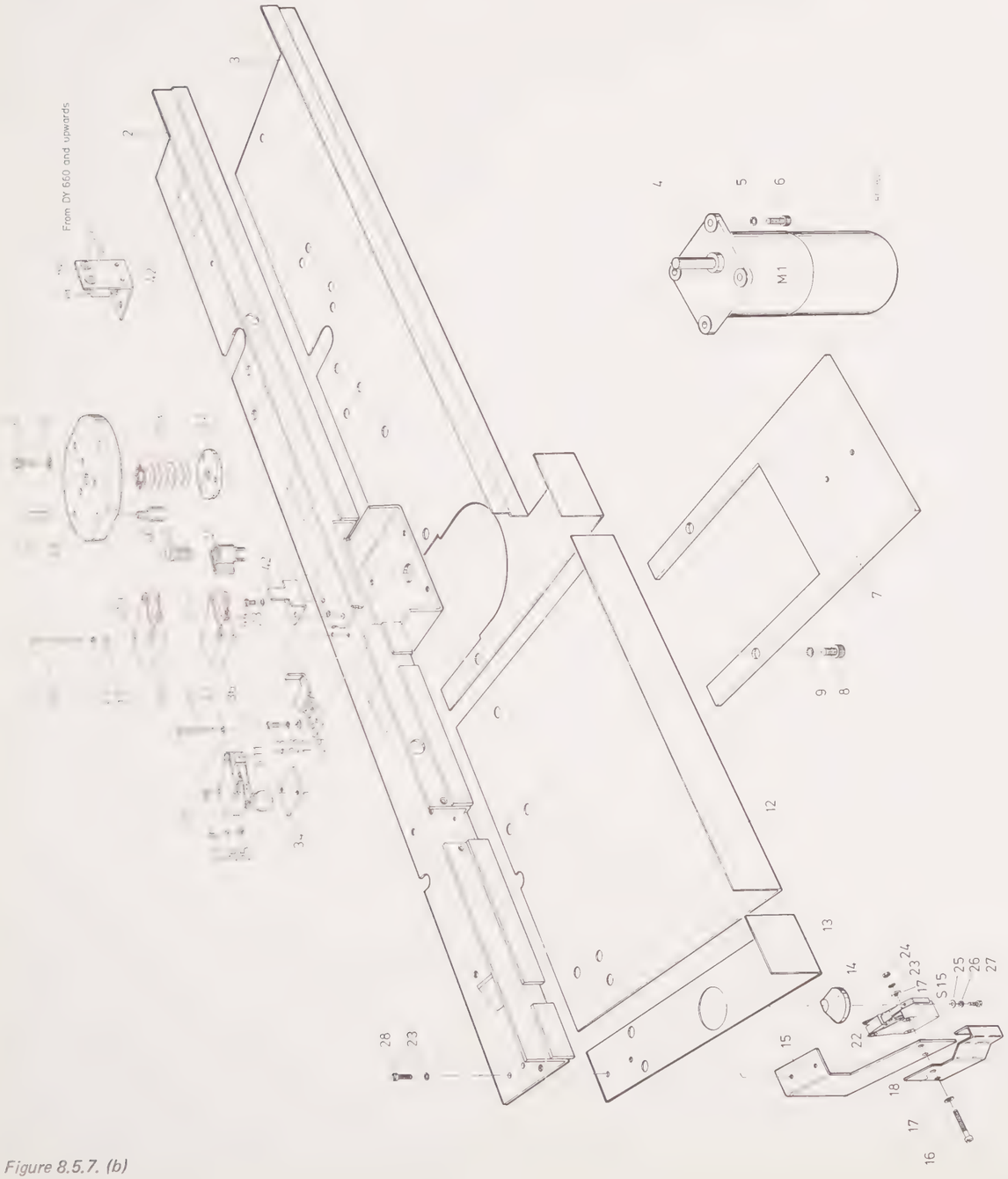

Figure 8.5.7. (b)

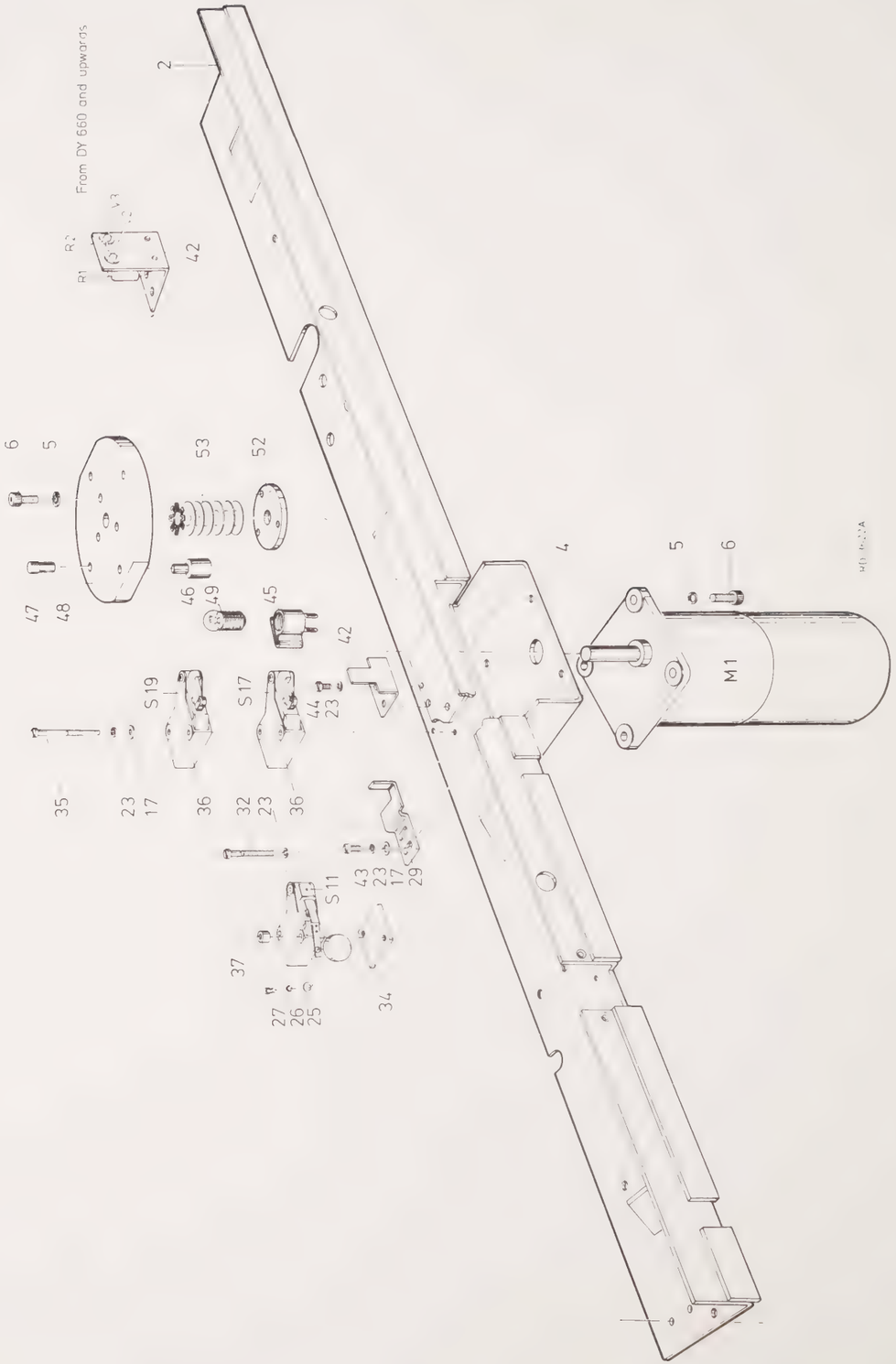

Figure 8.5.7. (c)

Miscellaneous parts

Item	*Ordering code*	*Description*
Parts supplied with sample changer and loader		
E1	5322 134 40146	Lamp 12875 12 V 3 W
Base V1	5322 255 40089	Transistor socket 4 P
V1	5322 130 44472	Phototransistor
Both mounted	5322 130 34285	Light emitter
in spectrometer	5322 130 34286	Light receiver
Electronic rack assy		
For F1	5322 256 34081	Fuse holder 5 x 20
For F2	5322 492 64336	Spring fuse holder
Capacitors		
C1A, 2A, 4, 5	5322 124 44011	20 µF +10 % – 10 % 220 V
C1B, 2B	5322 124 44012	25 µF +10 % – 10 % 220 V
C3	5322 121 14073	4 µF Siemens 400 V 50/60 Hz type B25833-A4405-K002
F1	4822 253 30021	Cartridge fuse 1 AT
F2	4822 253 30018	Cartridge fuse 630 mA T5 x 20
T1	5322 146 34091	Transformer TE 1650
		Solid relay
V2	5322 280 74108	Optrol 240-D10
		Wiring loom Y-motor 4022 332 64800
X5C	5322 265 34032	Connector 4-pole Tuchel 3110-000
		Wiring loom arm mech 4022 332 64810
X4A	5322 265 54044	Connector block RH 25-pole pin Amp 205208-1
	5322 268 14133	Contact pin Amp 66506-9
		Wiring loom opt read 4022 332 64820
X3	5322 265 64028	Contact block mod 4 50-pole pin Amp 5-925369-0
	5322 268 24108	Contact mod 4 0,14 x 0,56 mm SQ Amp. 141603-3

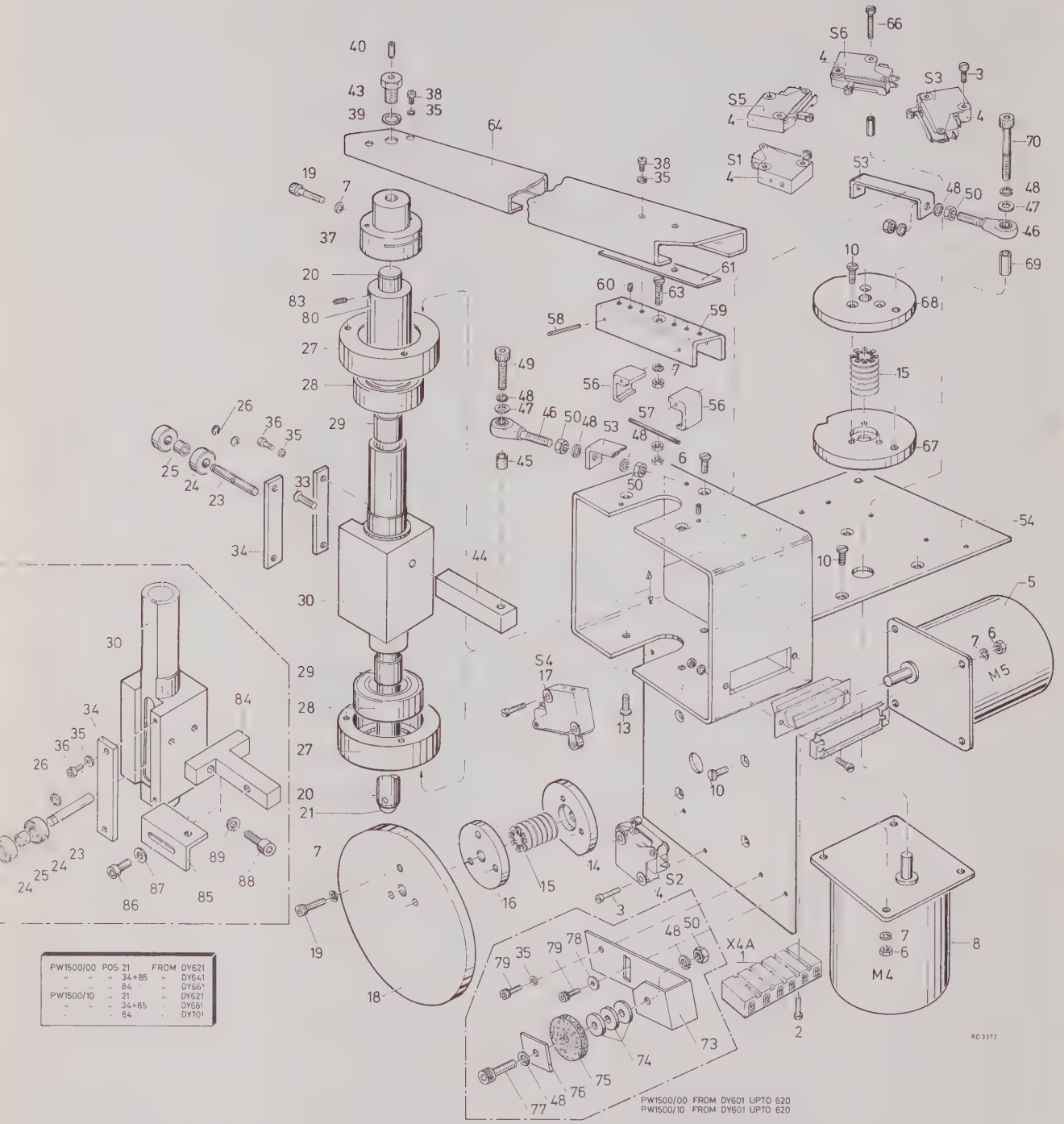

Figure 9.2K Grab arm mechanism

2. New LED emitter and receive for sample in pick-up position

In a few installations it is possible that very bright lights (e.g. sunlight) can be reflected by the sample holder in the pick-up position into the photocell, resulting in a signal indicating that no sample is present. This leads to an error condition and the system being stopped.

In those installations where this problem occurs it is possible to replace the existing lamp and photocell assemblies with an infra-red LED and detector. In the original arrangement, the lamp also functioned as an indication that the sample changer/loader was switched on. This function is now performed by a yellow LED which is connected in parallel with the infra-red LED. In order to be able to see this LED it is also necessary to replace the protective cap with one with a horizontal slot. Also, to reduce the possibility of interference, an infra-red filter has be placed in front of the receiver.

A kit consisting of LED panel, photo diode panel, mounting material, protective cap, and filter is available from Concern Service under ordering code 5322 694 14563. The kit should be fitted in place of the existing components as shown in Fig. 1. Stick the filter to the inside of the receiver cap with a cyano acrylate adhesive. This modification has been fitted in production units as follows:

PW1500/00/05/06 starting with serial number DY641
PW1500/10/15/16 starting with serial number DY701

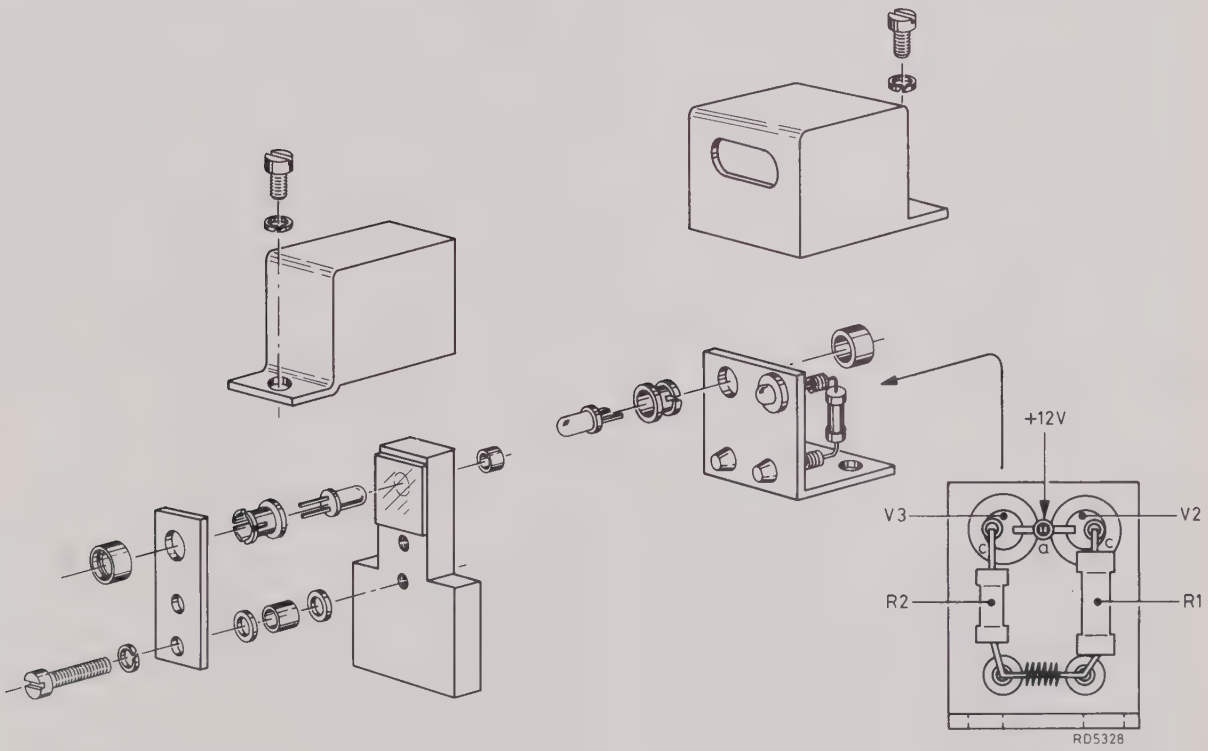

Fig. 1. Installation of LED emitter and receiver

Adjustment procedure

1. Switch on the sample changer with no sample holder in the pick-up position.
2. Connect a resistor of 10kΩ in parallel to R21 on the Microswitch Buffer Board.
   To locate R21, refer to figure 8.5.3. in the PW1400/00 Service Manual or figure 9.2T in the PW1600/10 Service Manual. Figure 2. below shows R21 and its associated circuit.
3. Connect a voltmeter in parallel with R21.
4. Adjust the position of the phototransistor until the voltmeter registers a maximum.
5. Wait 10 minutes to allow the temperature of the phototransistor to stabilize.
6. Adjust the value of the resistor in parallel to R21, such that the voltmeter registers 11 ± 0,1Volts.
7. Place a sample holder in the pick-up position. The voltage must now be less than 0,1Volt.

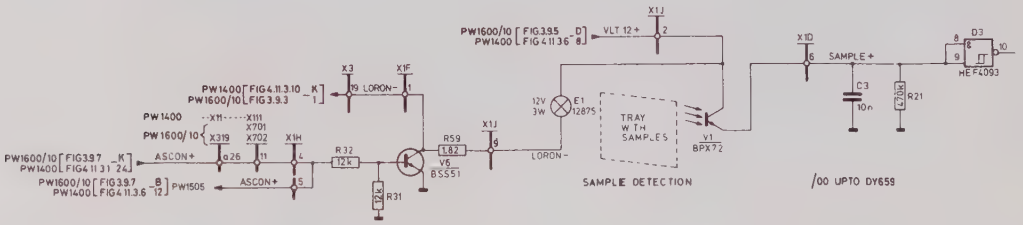

Fig. 2. R21 and the phototransistor

3. New 50Hz and 60Hz motors

In place of the universal 50/60Hz motors (M3) fitted to earlier units two new motors have been introduced for 50Hz and 60Hz models respectively. If the universal motor gives problems it may be replaced by the appropriate motor as follows:

M3	ordering code
50Hz	5322 694 14585
60Hz	5322 694 14584

These motors have been fitted in production units as follows:

PW1500/10/15/16 starting with serial number DY728.

For the PW1500/06/16, two new 60Hz motors have been introduced for the arm mechanism:

Motor M4	5322 361 20381
Motor M5	5322 361 20379

These motors will be fitted in production units delivered after february 1983.

Documentation changes:

In the PW1400/00 Service Manual; replace page 8-172 with the replacement page attached.
In the PW1600/10 Service Manual; replace page 9-56 upto 9-58 with the replacement pages attached.

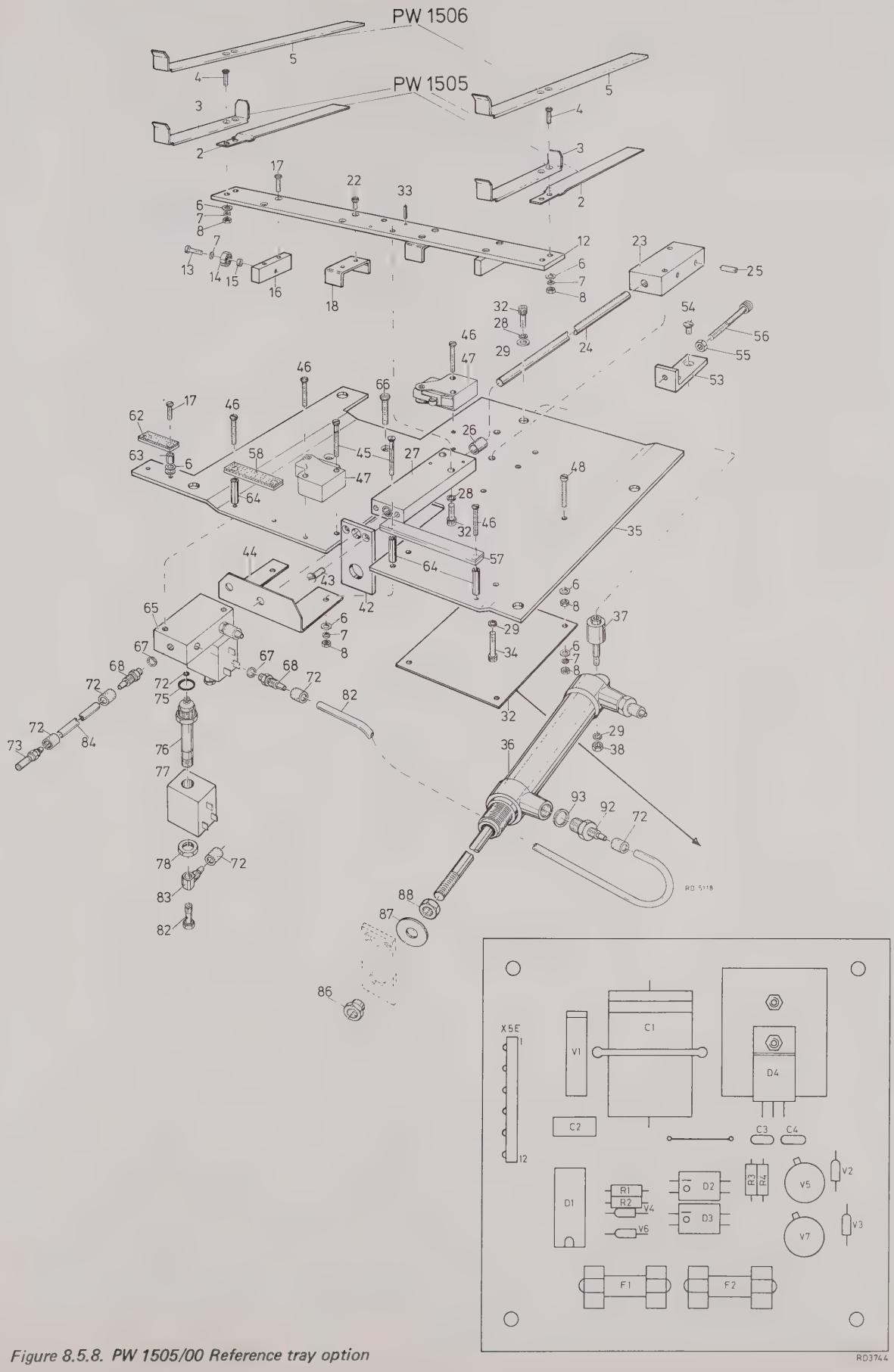

Figure 8.5.8. PW 1505/00 Reference tray option

8.5.9. PW1500/10/15/16 sample changer tray transport

Item	Description	Ordering code
	Locking slide 4022 331 63760	5322 268 44137
	Transport mechanism 4022 331 62230	
2	Spring dowel 3 x 24 mm	5322 529 50051
3	Transport wheel	5322 522 34775
4	Retaining ring	4822 530 70128
5	Ball bearing single row sealed 12 x 28 x 8	5322 520 20157
6	Drive belt	5322 535 94886
8	Spring dowel 3 x 20	5322 529 50049
9	Bevel gearwheel	5322 535 94877
26	Transport belt	5322 358 24108
37	Transport belt	5322 358 24109
38	Shaft	5322 535 94887
68	Pawl	5322 526 54248
69	Spring	5322 492 64669
79	Disc assembly	5322 466 85745
117	Ball bearing single row sealed 6 x 19 x 6	5322 520 20014
118	Transport wheel flat	5322 528 74213
C3	Capacitor 4 μ F 400 V	5322 121 14073
	Siemens 50/60 Hz type	
	B25833-A4405-K002	
M1,2	Motor	5322 361 84211
M3	Motor 60Hz	5322 694 14584
	Motor 50Hz	5322 694 14585
S11, 12, 15, 16	Microswitch assembly	5322 271 34194
S13, 14	Microswitch assembly	5322 694 14586
S17, 18, 19	Microswitch assembly	5322 271 34064

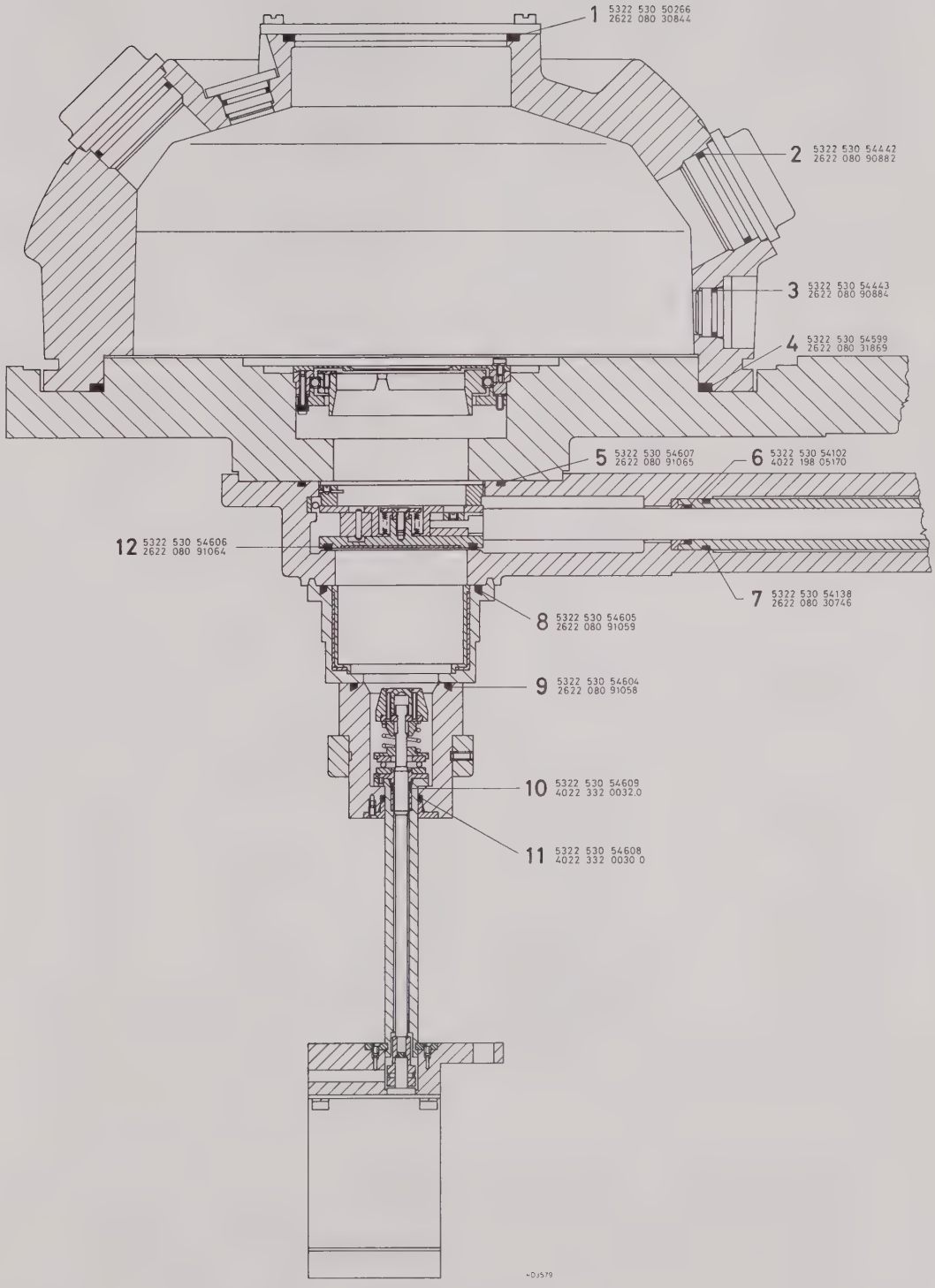

Figure 9.2J. *Vacuum seals spectrometer chamber*

9.2.6. Sample loader/changer

Mechanical parts

Item	*Ordering code*	*Description*
Grab arm mechanism (figure 9.2K)		
23-26	5322 535 74563	Grab arm slot pin
29	5322 520 34173	Sleeve bearing
24	5322 520 20122	Ball bearing single row sealed 5x16x5
26	4822 530 70123	Retaining ring 3.2 mm
28	5322 520 24184	Ball bearing single row sealed 25x47x12
15	5322 530 84098	Slotted belville washer A8 SS 18
18	5322 466 85747	Cam
46	5322 520 14276	Self-aligning rod-end bearing M5
37	5322 532 34112	Clamp
43	5322 500 14246	Special bolt
67, 56 ... 60, 63	5322 693 14011	Grab assembly
80	5322 268 94008	Locking slide Cannon DB51221
M4	5322 361 84212	Synchronous motor 24V 50Hz
	5322 361 20381	Synchronous motor 24V 60Hz
M5	5322 361 20377	Synchronous motor 24V 50Hz
	5322 361 20379	Synchronous motor 24V 60Hz
S1-6	5322 271 34064	Microswitch assembly
X4B	5322 290 64152	Connector block 6-p
X4A	5322 265 54044	Contact block 25-pole pin Amp 20S208-1
	5322 268 14133	Contact pin AMP 66509-9
PW 1500/00 Sample loader mechanism, see figure 9.2L		
M1	5322 361 84211	Motor
S11, S15	5322 271 34194	Microswitch assembly 82790
S17	5322 271 34064	Microswitch assembly
PW 1505/00 Reference tray option, see figure 9.2M		
	5322 694 14432	Valve control complete
IC + semi-conductors		
D1	5322 209 14049	HEF 4049 BP
D2, 3	5322 130 94018	CNY63 optocoupler
D4	5322 209 86102	78HV24CU volt. regulator
V1	4822 130 30414	BY164 diode
V2-4, 6	4822 130 30613	BAW62 diode
V5, 7	5322 130 44451	BSS51 transistor
Fuses		
F1, 2	4822 253 20014	Fuse 500 mA delayed
PW1500/10/15/16 Sample changer tray transport, see figure 9.2N		
	5322 268 44137	Locking slide 4022 331 63760 Transport mechanism 4022 331 62230
26	5322 358 24108	Transport belt
6	5322 535 94886	Drive belt
3	5322 522 34775	Transport wheel
2	5322 529 50051	Spring dowel 3 x 24 mm
5	5322 520 20157	Ball bearing single row sealed 12 x 28 x 8
9	5322 535 94877	Bevel gearwheel
8	5322 529 50049	Spring dowel 3 x 20
4	4822 530 70128	Retaining ring
117	5322 520 20014	Ball bearing single row sealed 6 x 19 x 6

Item	*Ordering code*	*Description*
38	5322 535 94887	Shaft
37	5322 358 24109	Transport belt
79	5322 466 85745	Disc assembly
69	5322 492 64669	Spring
68	5322 526 54248	Pawl
M1,2	5322 361 84211	Motor
M3	5322 694 14584	Motor 60Hz
	5322 694 14585	Motor 50Hz
S11, 12, 15, 16	5322 271 34194	Microswitch assembly
118	5322 528 74213	Transport wheel flat
C3	5322 121 14073	Capacitor 4 μF 400 V Siemens 50/60 Hz type B25833-A4405-K002
S13, 14	5322 694 14586	Microswitch assembly
S17, 18, 19	5322 271 34064	Microswitch assembly
Changer control A319, see figures 9.2P, 9.2Q and 9.2R		
A319	5322 694 14378	Sample changer control p.c.b. complete
Integrated circuits		
D1	5322 209 14191	HEF4528BP
D2, 5, 6, 13, 30, 42	5322 209 14046	HEF4011BP
D3, 4	5322 209 14244	HEF4043BP
D7, 8, 21	5322 209 14433	HEF40097BP
D9, 25, 27	5322 209 10002	HEF4013BP
D10, 33, 41	5322 209 14065	HEF4023BP
D11, 22, 28, 36	5322 209 14045	HEF4001BP
D12	5322 209 14269	HEF4040BP
D14-16	4822 209 10004	HEF4556BP
D17	5322 209 14103	HEF4024BP
D18	5322 209 14058	HEF4085BP
D20, 35	5322 209 14047	HEF4012BP
D23, 24, 19, 37	5322 209 14053	HEF4071BP
D26	5322 209 14067	HEF4075BP
D29	5322 209 14234	HEF4078BP
D31, 39	5322 209 14072	HEF4044BP
D32, 43	5322 209 14054	HEF4081BP
D34, 40	5322 209 14128	HEF4069UBP
D38	5322 209 14074	HEF4072BP
Diodes		
V1,2,3	4822 130 30613	BAW62
Microswitch buffer p.c.b. A1, figures 9.2S and 9.2T		
A1	5322 694 14377	Micro-switch buffer p.c.b. complete 4022 332 82790
Capacitors		
C1, 2, 18, 23, 7	5322 121 40323	100 nF 10 % 100 V
C3-6, 8-17, 19-22	4822 122 30043	10 nF −20+80 % 40 V
C24	4822 124 20534	680 μF −10+50 % 40 V

Item	Ordering number	Description		
Integrated circuits				
D1, 2, 7, 8	5322 209 14072	HEF4044BP		
D3, 5, 6, 10, 11	5322 209 14186	HEF4093BP		
D4, 9, 12	5322 209 14304	HEF40098BP		
D13	5322 209 85603	7812CU		
Diodes				
V1-3	4822 130 30613	BAW62		
V4, 5	5322 130 30765	BZX75-C3V6		
V11	4822 130 30414	BY164		
Transistors				
V6	5322 130 44451	BSS51		
Motor drive p.c.b. A2, see figure 9.2U				
	5322 694 14366	Motor drive P.c.b. complete 4022 332 82550		
Capacitors				
C1	4822 124 20534	680 µF	−10+50 %	40 V
C2, 3, 5, 6, 8, 9	4822 121 40252	6,8 µF	10 %	100 V
C4, 7, 10	5322 121 40224	4.7 µF	10 %	100 V
C11	5322 121 40323	100 nF	10 %	100 V
Integrated circuits				
D1	5322 209 14444	HEF4017BP		
D2-7	5322 209 86029	CNY62		
Transistors				
V1-6	4822 130 44257	BC547		
V7-8	4822 130 44256	BC557		
V9	4822 130 40665	BD138		
Diodes				
V10	4822 130 30839	BY206		
V11	4822 130 34197	BZX79-C12		
C12, 13, 20	5322 130 34605	BAX12A		
V14-19	5322 130 24079	BT139-600 triac		
Fuses				
F1-6	4822 253 30021	1 A delayed 5 x 20		
Optical reader p.c.b. A3, see figure 9.2V				
	5322 694 14388	Optical reader P.c.b. complete		
	5322 265 64091	Header strip 50 pole		
X3		180 deg Amp 5-825433-0		
Transistors				
V1-4, 13-20, 29-32	5322 130 44754	Photo transistor BPW22		
Diodes				
V5-12, 21-28	5322 130 34677	LED CQY58 A/1		

4. **Additional support for top platform**

In certain models of the PW1500/10/15/16 if it is possible that the tension of the drive belt between the gueueing motor and the gueueing belts can cause distortion of the top plate. The result of this is that the sample trays vibrate when the belt drive is running. If this problem exists it is possible to fit a support strip [60] between the motor mounting plate and the bearing support (see new fig. 8.5.9. for PW1400/00 Service Manual or fig. 9.2N1 for the PW1600/10). In order to fit this strip it will be necessary to drill a hole in the motor mounting plate to take the screw [52].

This support strip can be ordered free of charge from S&I Almelo, with the code number 4022 332 33180 see "Ordering Procedure" at the end of this service bulletin.

The support strip has been fitted in production units, starting with serial number DY710.

Documentation changes:

In the PW1400/00 Service Manual; replace page 8-174 with the replacement page 8-174 attached.
In the PW1600/10 Service Manual; replace page 9-68 with the replacement page 9-68 attached.

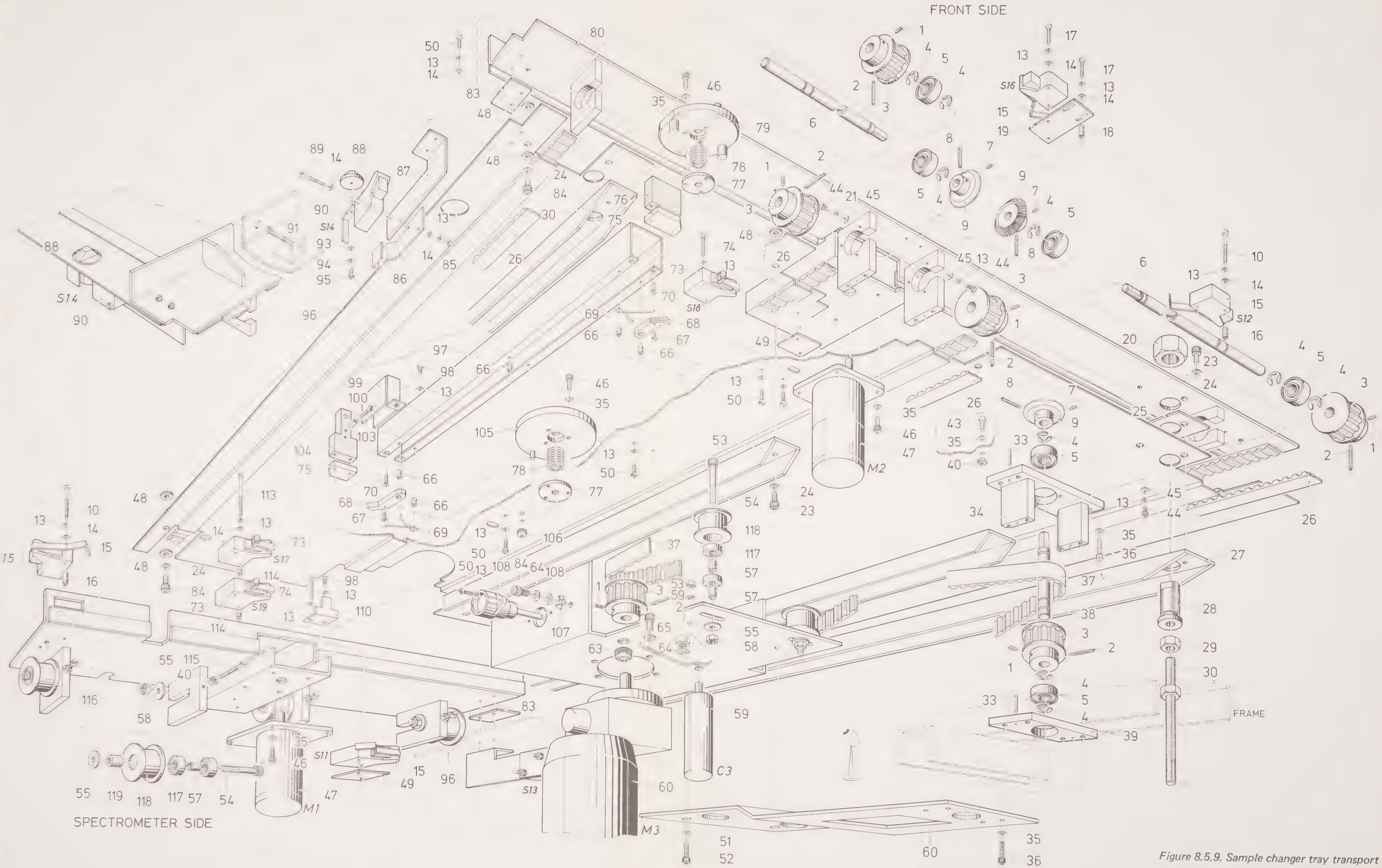

Figure 8.5.9. Sample changer tray transport

Parts delivered with PW1500/00/05/06 and PW1500/10/15/16.

Item	Qty.	Description	Factory code number	Service code number
	1	Sample changer control p.c.b.	4022 331 70650	5322 694 14378
	1	Light emitter	2711 032 01001	5322 130 34285
	1	Light receiver	2711 032 01011	5322 130 34286
	2	Coverplate	4022 332 18170	
	4	Screw/washer/spring washer		
	1	Allen key 8mm	2622 150 09022	4822 395 50092
	1	6mm	4022 331 70860	5322 395 54083
	10	Fuse 1A delayed	2422 086 00338	4822 253 30021
	10	Fuse 630mA delayed	2422 086 00336	4822 253 30018
	1	Lamp	4022 332 31430	5322 134 40146
		Screw driver	2622 150 11104	5322 395 50146

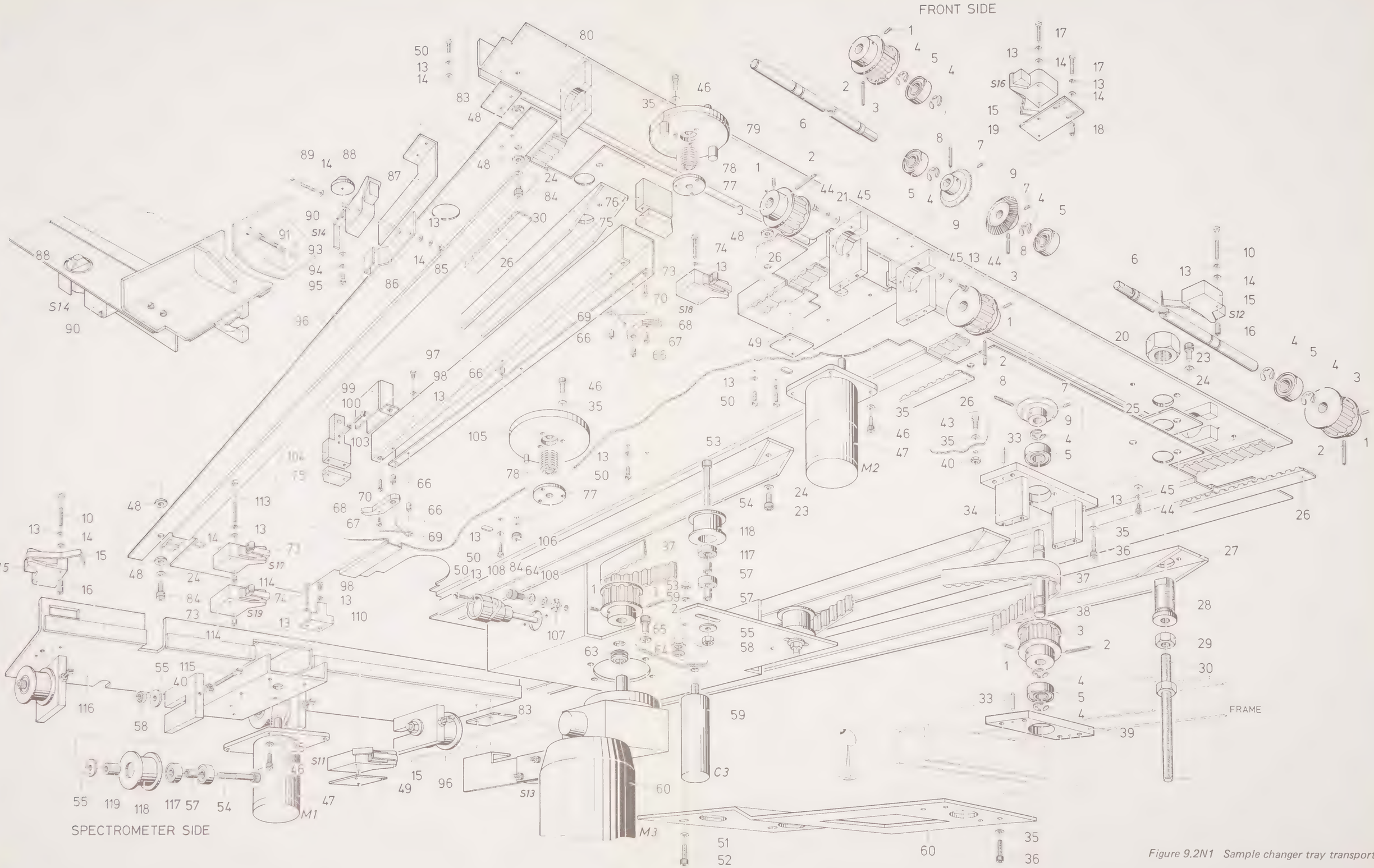

Figure 9.2N1 Sample changer tray transport

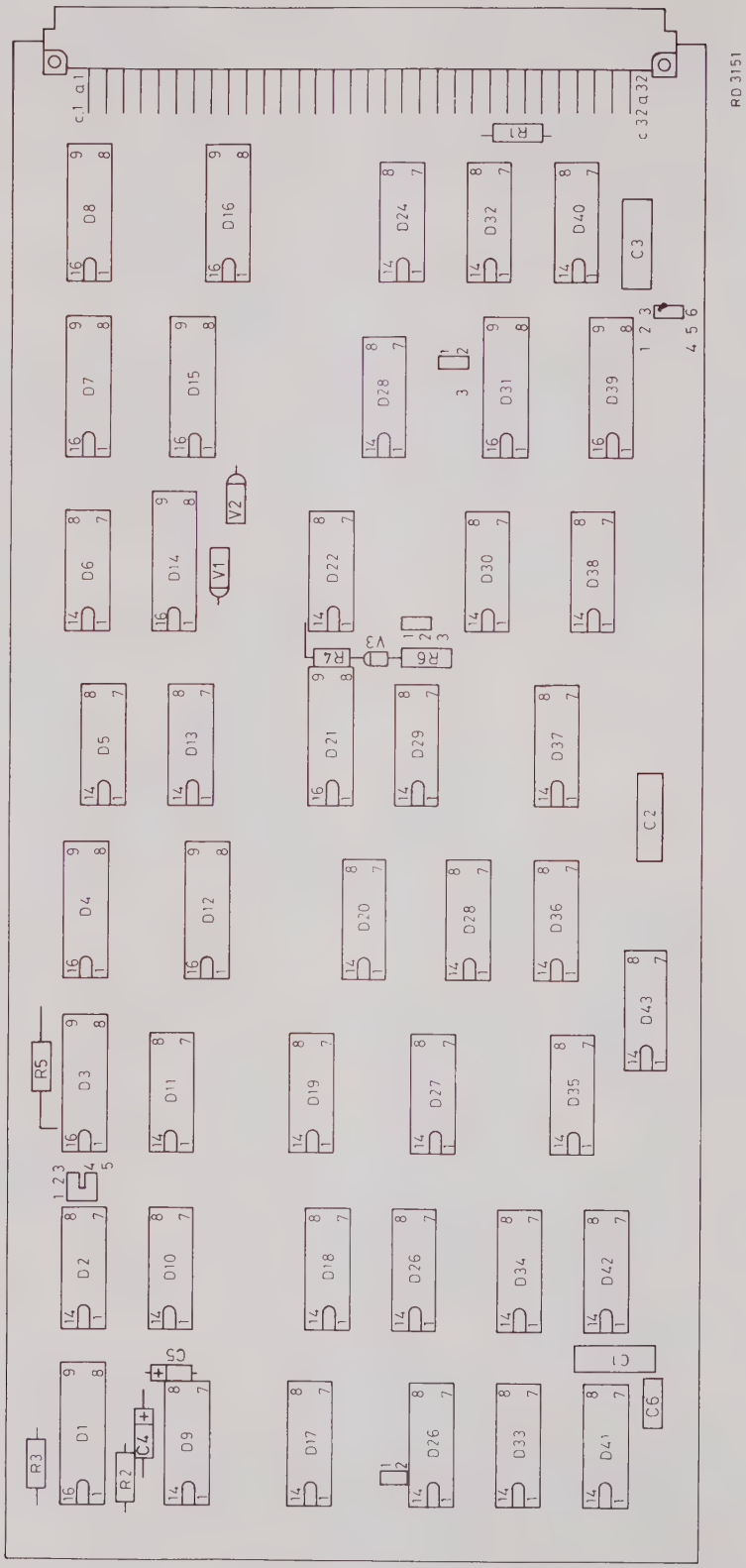

Figure 9.2P. *Changer control p.c.b. A319 – component lay out*

5. New microswitches

The microswitches with mushroom shaped actuators in the corners of the top plate have been replaced by a less sensitive type which is less subject to false signals caused by vibration.
This new microswitch, complete with actuator, can be ordered from Concern Service with the ordering code 5322 694 14586.

The new microswitch has been fitted in production units as follows:

PW1500/05/06 starting with serial number DY671
PW1500/15/16 starting with serial number DY741.

6. New infra-red emitter and receiver for "Sample under cap" signal

An infra-red emitter and receiver set has been introduced to generate the "Sample under cap" signal. The set consists of two separate units which are mounted opposite each other on either side of the spectrometer loading opening. It replaces the original set which was based on a filament lamp and photodiode.

a. Installation in PW1400/00

See figure 3a. for mounting details and fig. 4. for electrical connection.

b. Installation in PW1600/10

See figure 3b. for mounting details and fig. 5. for electrical connection.

Alignment of the emitter and receiver must be done by using the slotted holes in the mounting plate to ensure that the "Sample under cap" signal is generated when a sample holder is placed in the loading opening.
This new emitter/receiver combination has been introduced in production units as follows:

PW1500/00/05/06 starting with serial number DY671
PW1500/10/15/16 starting with serial number DY736

The complete emitter and receiver assemblies will not be available as spare parts - retrofit is not required.

SPARE PARTS

V1, 2	LED 1R	CQY89A-I	9335 117 60112
V1	Phototransistor	BPX95C-II	9335 334 90112

Ordering procedures:

If you require any of the parts mentioned in this service bulletin to be supplied free-of-charge, they can be ordered through:

S&I Logistics
Nederlandse Philips Bedrijven B.V.
Lelyweg 1
7602 EA Almelo
The Netherlands

Quote the ordering code given in the appropriate part of this bulletin.

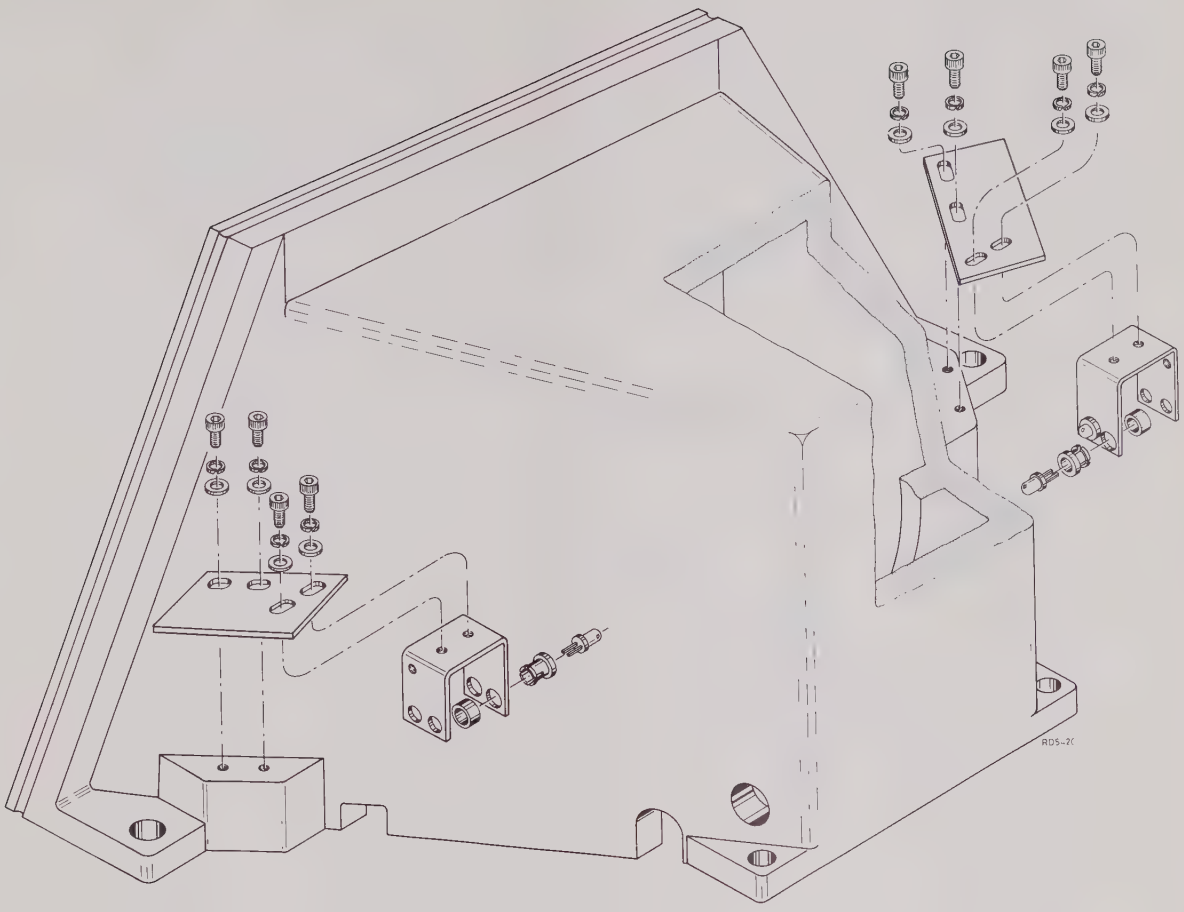

Figure 3a.

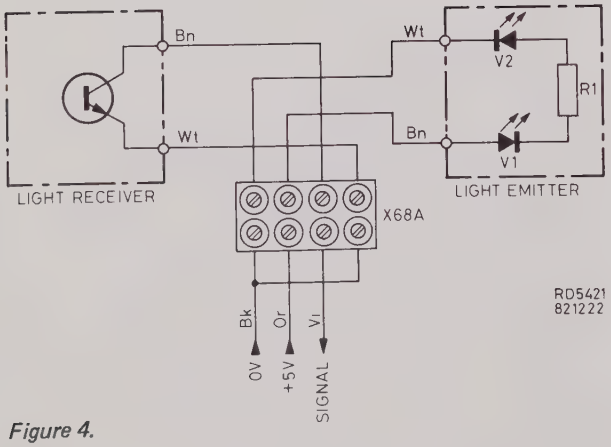

Figure 4.

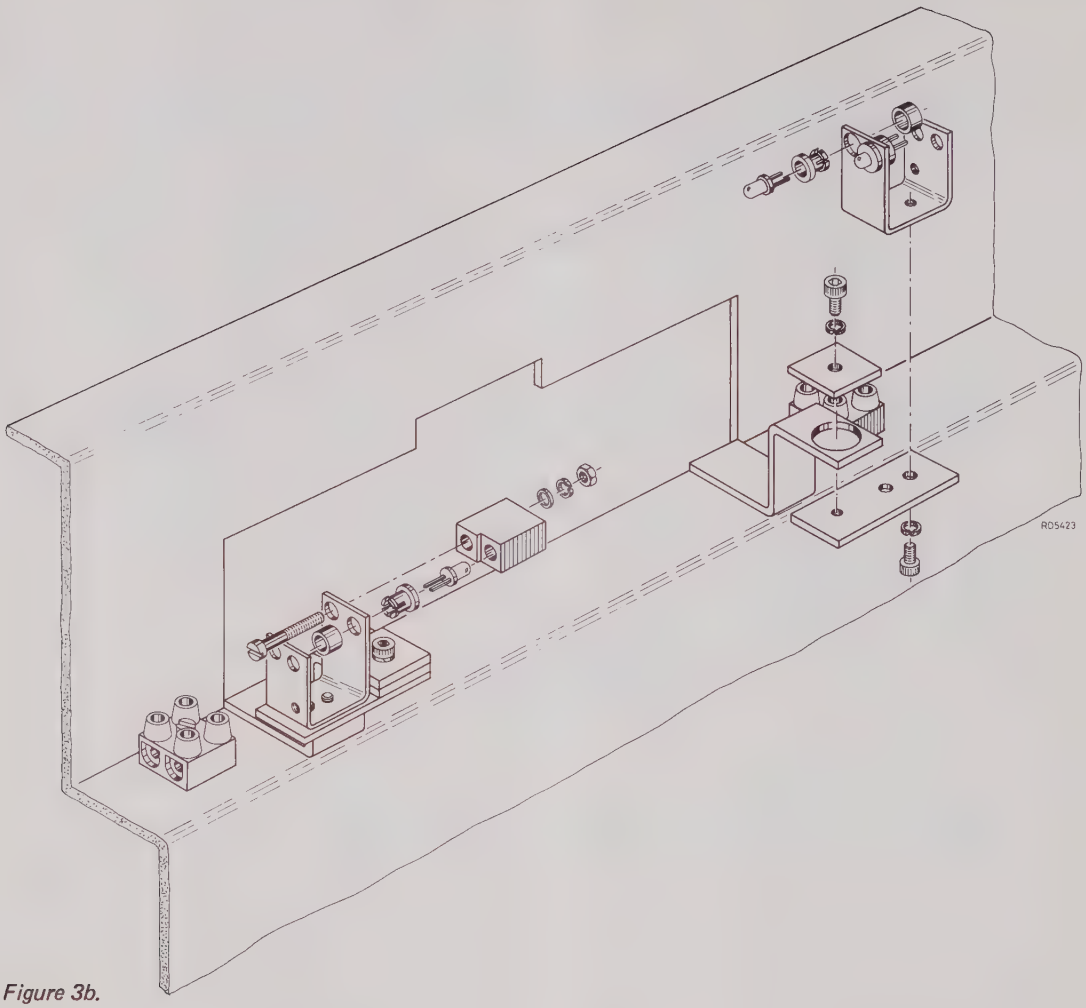

Figure 3b.

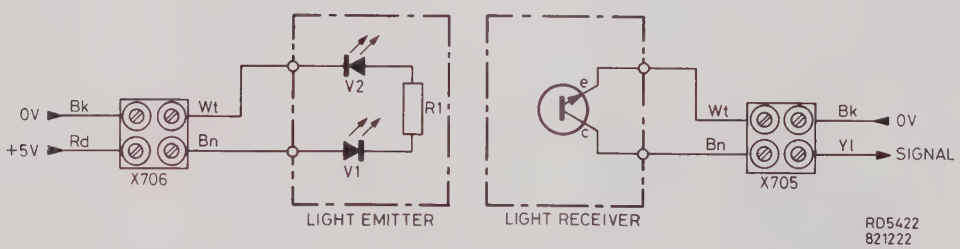

Figure 5.

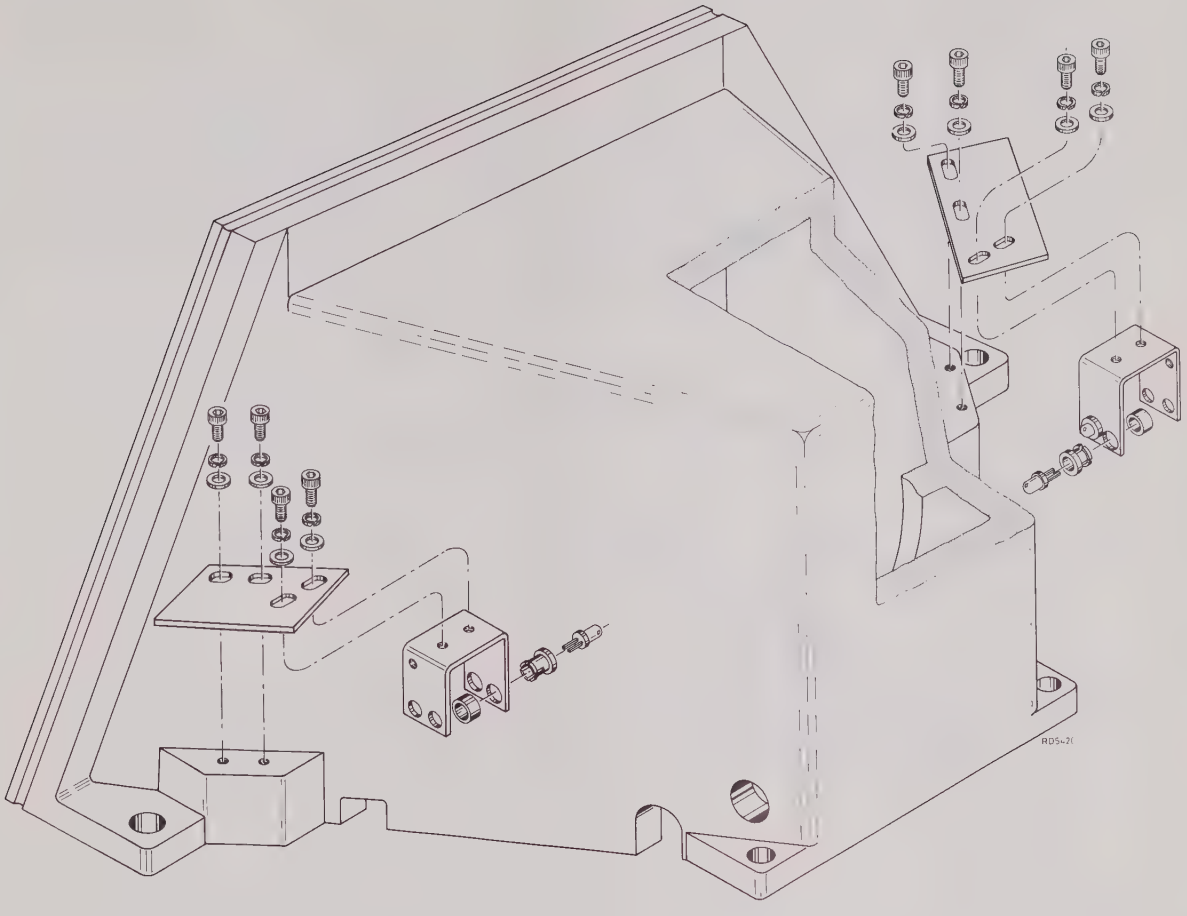

Figure 3a.

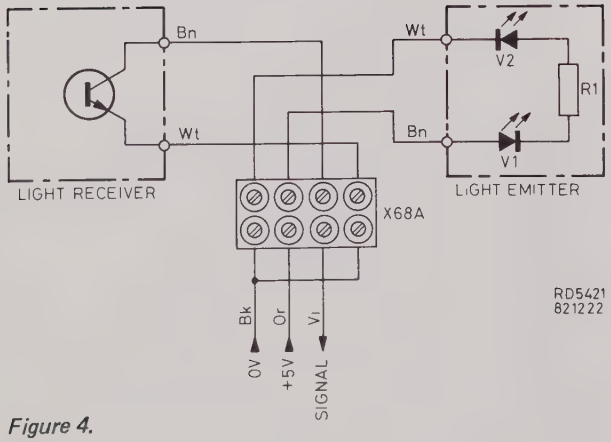

Figure 4.

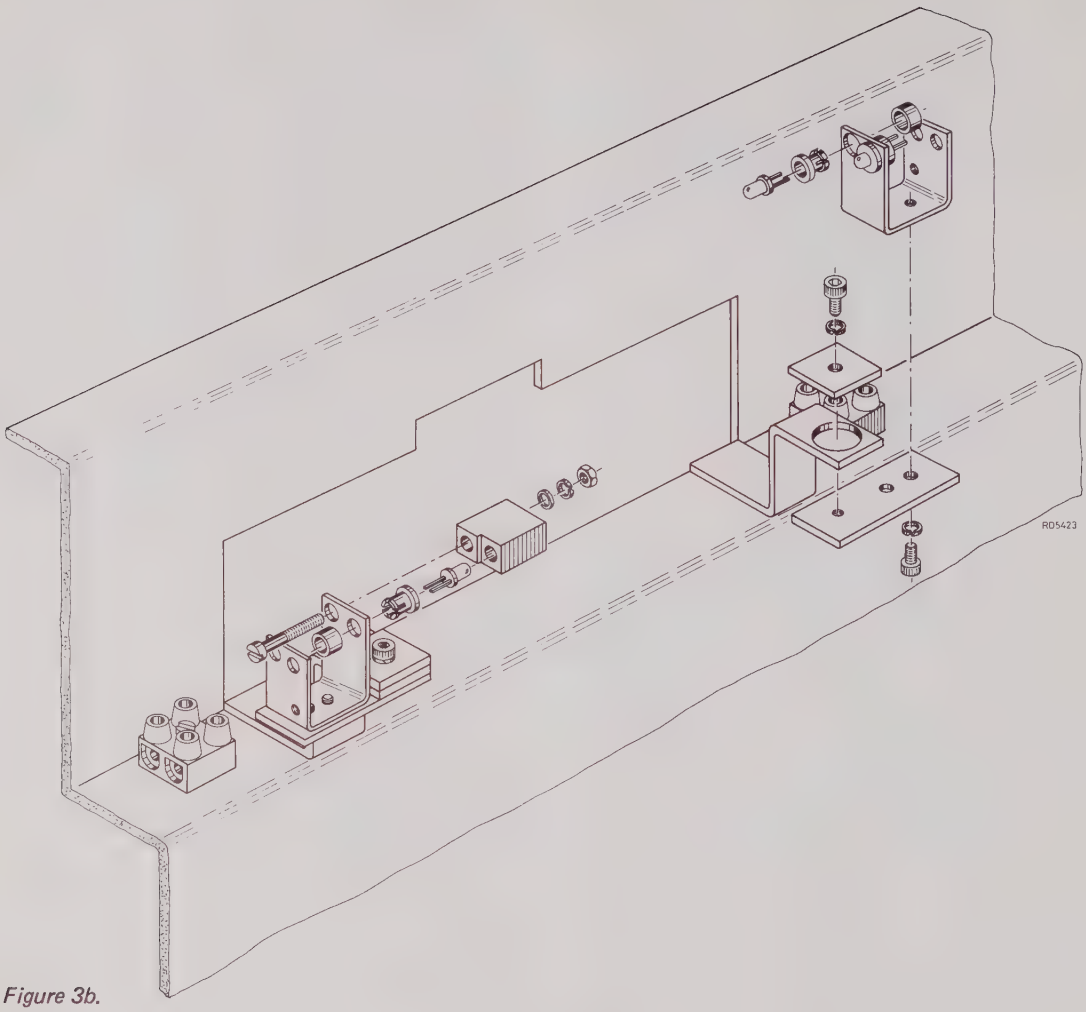

Figure 3b.

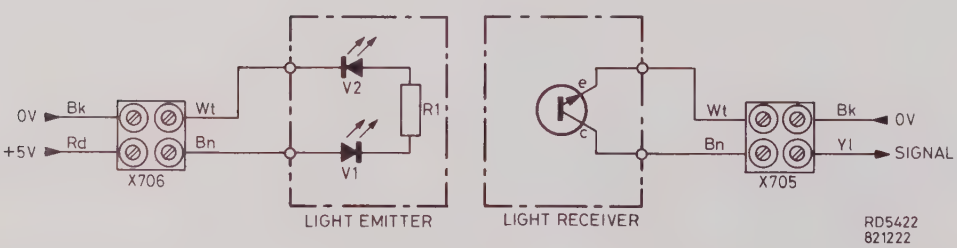

Figure 5.

PHILIPS

PHILIPS

SERVICE

Scientific & Analytical Equipment
Test & Measuring Instruments
Industrial Automation
Advanced Automation Systems
Welding

Scientific & Industrial Equipment Division

821201 | PW1400/00 | XRA196

Action:

URGENT. Add extra lead radiation shield to table top at earliest possible moment.

Already issued:

XRA141, 142, 150, 153, 157, 162, 167, 169, 178, 179, 180, 181, 183, 189.

It is possible that in certain limited circumstances a small X-ray leak can take place through the table top of the PW1400/00. Although it is unlikely to occur in most applications, it is considered essential that an extra lead shield be fitted to the underside of the table top of all spectrometers as soon as possible.
This shield has been fitted in production units starting with serial number DY1001.

PROCEDURE

1. Demount the table top.
2. Place the lead shield in the correct position on the underside of the table top (see fig. 1). The new shield now overlaps the existing shield.
3. Using a drill bit of 4mm diameter, mark the position of the holes in the lead shield on the underside of the table top.
4. Remove the lead shield, and using a drill bit of 2mm diameter, drill five holes in the marked positions to a depth of 12mm.
5. Place the lead shield in position and fasten it with the screws provided.
   Be careful not to overtighten the screws.

ORDERING INFORMATION

A kit consisting of lead shield and fixing screws can be ordered free of charge from:

Mr. H. Rotman
Philips Scientific and Industrial Equipment Division
Lelyweg 1
7602 EA Almelo
The Netherlands

Please state on the order: Lead Shield Kit 4022 334 01220 and specify the serial number of the spectrometer for which it is required.

SAFETY · SAFETY · SAFETY · SAFETY

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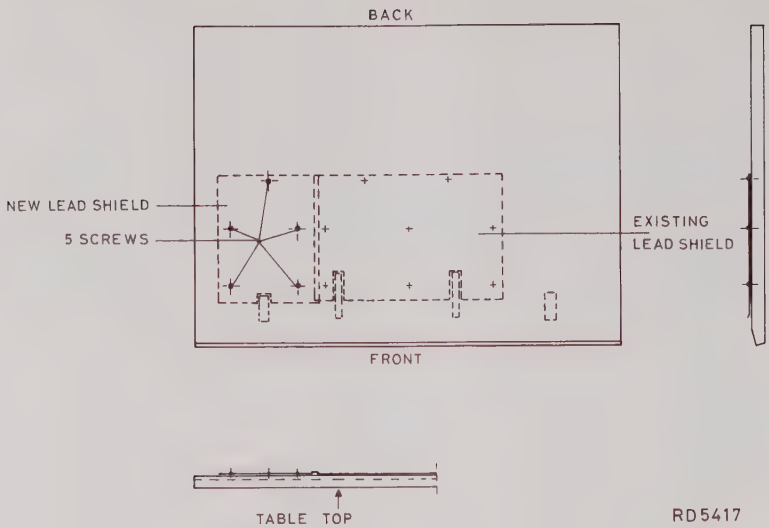

Fig. 1. Position of extra lead shield

PHILIPS

SERVICE

Scientific & Analytical Equipment
Test & Measuring Instruments
Industrial Automation
Advanced Automation Systems
Welding

Scientific & Industrial Equipment Division

830307 **PW1400/00** **XRA201**

Action:

1. Substitute new pages in Service Manual (Power supply A34)
2. Insert new pages in Service Manual (water connections)
3. Insert new pages in Service Manual (new heater)

Already issued:

XRA141, 142, 150, 153, 156, 157, 159, 161, 162, 164, 167, 178, 179, 180, 181, 183, 189, 196

1. The capacitor types used for C1 and C2 on the power supply pcb A34 are no longer available, and starting with serial number DY1201, a number of smaller capacitors will be substituted in production.
This has made it necessary to change the value of R3.

C1	becomes	5 x 2200 µF	−10 +50%	40 V	5322 124 74172
C2	becomes	2 x 2200 µF	−10 +50%	40 V	5322 124 74172
R3	becomes	6E8	5%	CR25	4822 112 41049

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2. Starting with serial number DY1100, the PW1400/00 will be delivered with a 'T' coupling and hose connectors to enable the spectrometer and X-ray generator to be connected in parallel to the water supply.

As a result of this the system will require a water supply of at least 8 litres per minute for single-tube operation and 12 litres per minute for simultaneous operation.

The method of connection for a PW1400/00 and PW1730 series generator is shown in the attached Fig. 3.11.1a.

The method of connection for simultaneous operation of spectrometer and diffraction set with one generator is shown in Fig. 3.11.2a.

Insert these figures in the appropriate places in the Service Manaul.

The spectrometer no longer has a water bypass fitted internally, so the previous method of connection may no longer be used.

3. Starting with serial number DY1051 a new heater assembly has been fitted. The new assembly and the service spares for it are shown on the accompanying pages. Insert these pages in the Service Manual.

Service spares for the existing heater will continue to be available.

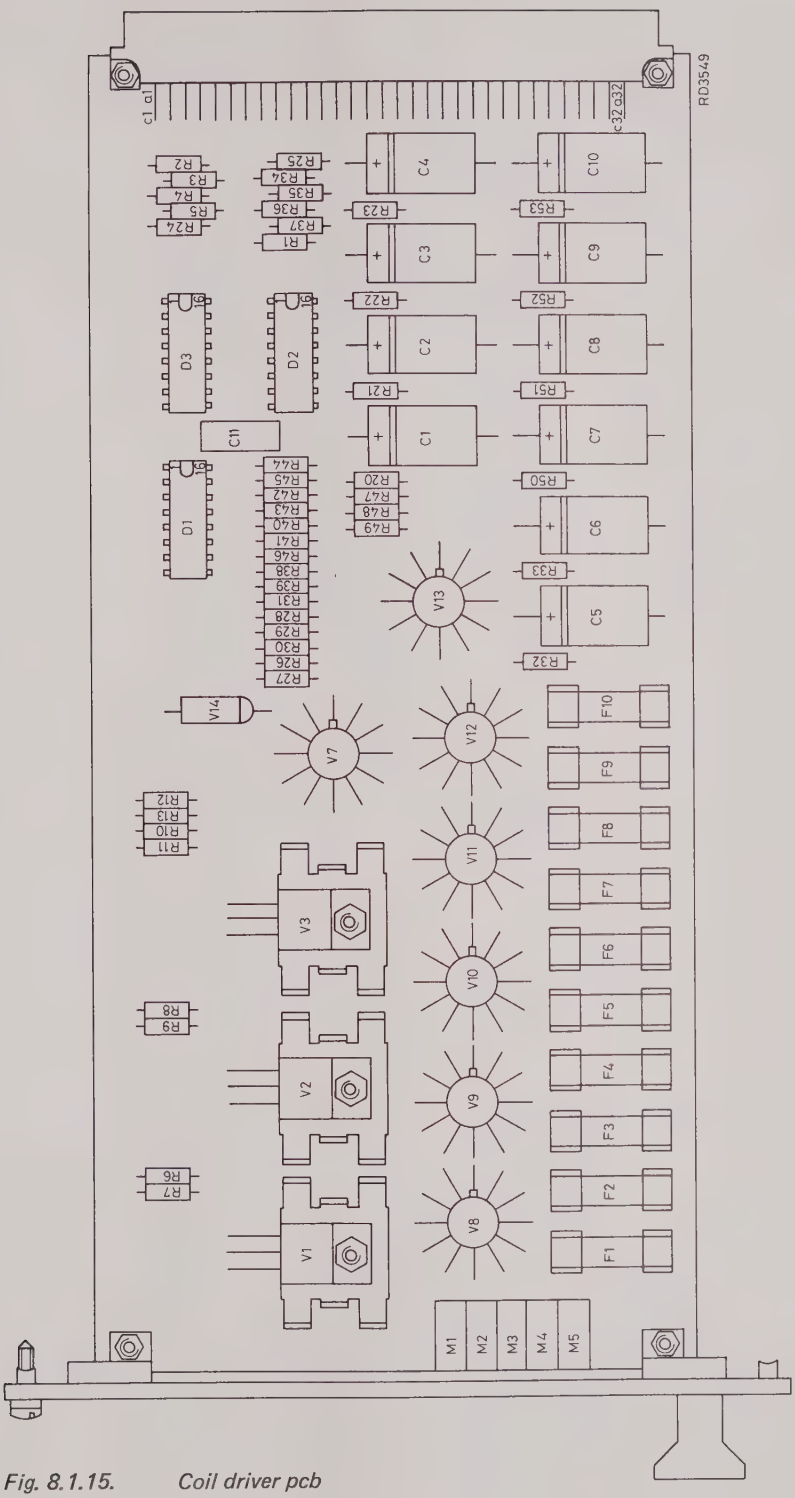


Fig. 8.1.15. Coil driver pcb

8.1.16. Power supply pcb A34

	Factory code 4022 332 8256			Ordering code 5322 694 14343
Item	*Description*			*Ordering code*
Capacitors				
C1 (5x)	2200 µF	−10 +50 %	40 V	5322 124 74172
C2 (2x)	2200 µF	−10 +50 %	40 V	5322 124 74172
C3, 4	680 µF	−10 +50 %	40 V	4822 124 20534
C5, 6	15 µF	−20 +20 %	10 V	5322 124 10017
C7-12	22 nF	−20 +80 %	40 V	4822 122 30103
Integrated circuits				
D1, 2	7824CU			5322 209 85833
D3	7812CU			5322 209 85603
Resistors				
R1, 2	1 E	5 %	CR25	4822 110 63027
R3	6E8	5 %	CR25	4822 112 41049
R4, 5	100 E	5 %	CR25	4822 112 41081
Diodes				
V1-4	BYX71-600			4822 130 34522
V5-8, 10	BY164			4822 130 30414
V9	BZX75-C2V1			4822 130 34049

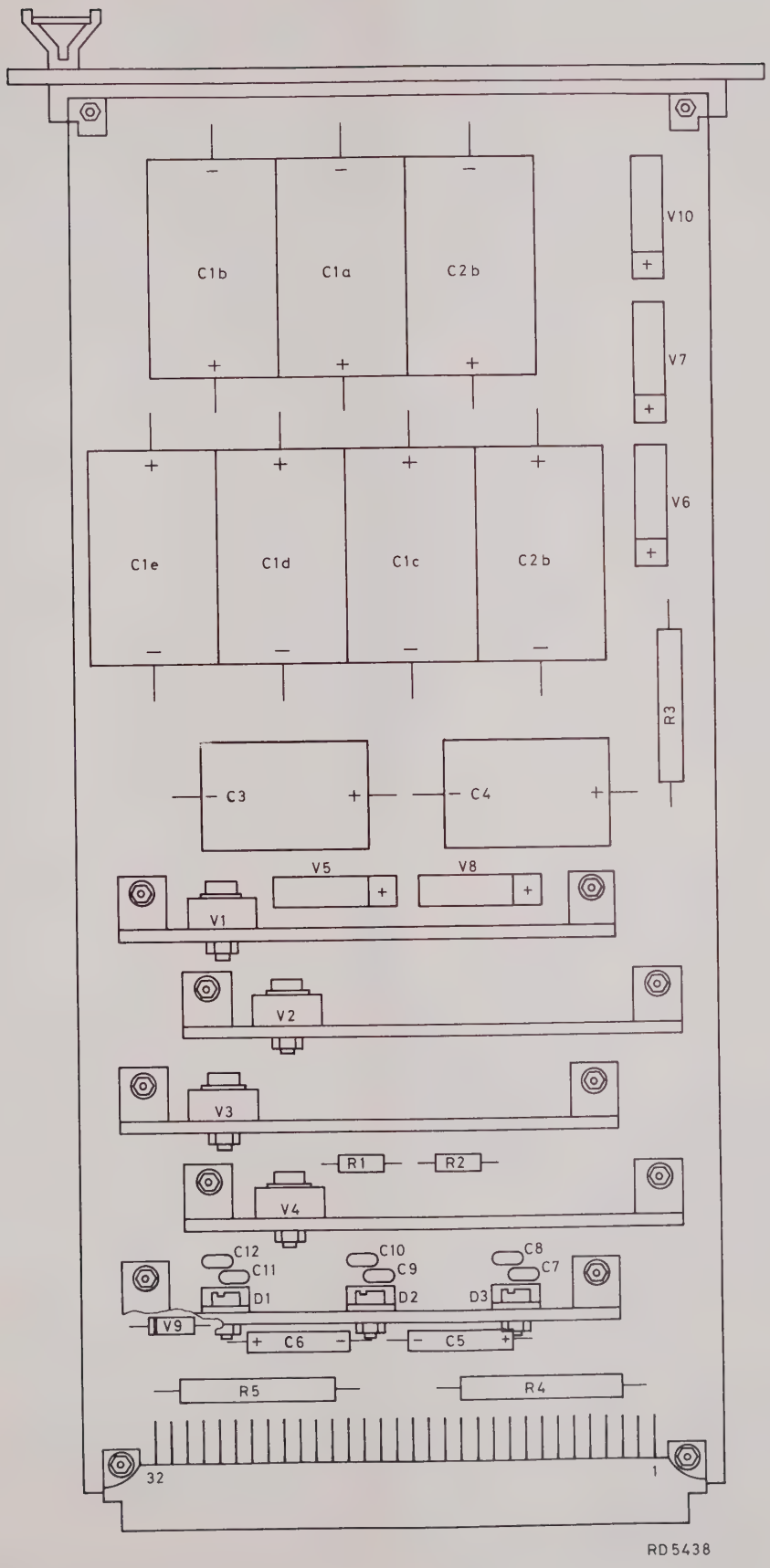


Fig. 8.1.16. Power supply pcb

8.1.17. Motor drive pcb A36

Factory code 4022 332 82550 — Ordering code 5322 694 14366

Item	*Description*			*Ordering code*
Capacitors				
C1	680 µF	−10 +50 %	40 V	4822 124 20534
C2, 3, 5, 6, 8, 9	6,8 µF	10 %	100 V	4822 121 40252
C4, 7, 10	4,7 µF	10 %	100 V	5322 121 40224
C11	100 nF	10 %	100 V	5322 121 40323
Integrated circuits				
D1	HEF4017BP			5322 209 14444
D2-7	CNY42			5322 209 84522
Resistors				
R1-6, 13-24, 27, 28	10 k	5 %	CR25	4822 110 63134
R7-12	100 k	5 %	CR25	4822 110 63161
R25	8E2	5 %	4,2 W	4822 112 21052
R26	620 E	5 %	CR25	5322 116 55028
R29	1 k	5 %	CR25	4822 110 43107
R30-32	15 E	5 %	7 W	4822 112 41058
R33-38	1 mA	20 %	56 V	4822 116 20101
R39-44	270 E	5 %	CR37	4822 110 53092
R45	470 k	5 %	CR25	4822 110 63178
Transistors				
V1-6	BC547			4822 130 44257
V7, 8	BC557			4822 130 44256
V9	BD138			4822 130 40665
Diodes				
V10	BY206			4822 130 30839
V11	BZX79-C12			4822 130 34197
V12, 13, 20	BAX12A			5322 130 34605
V14-19	BT139-600	TRIAC		5322 130 24079
Fuses				
F1-6	1 A	T 5X20		4822 253 30021

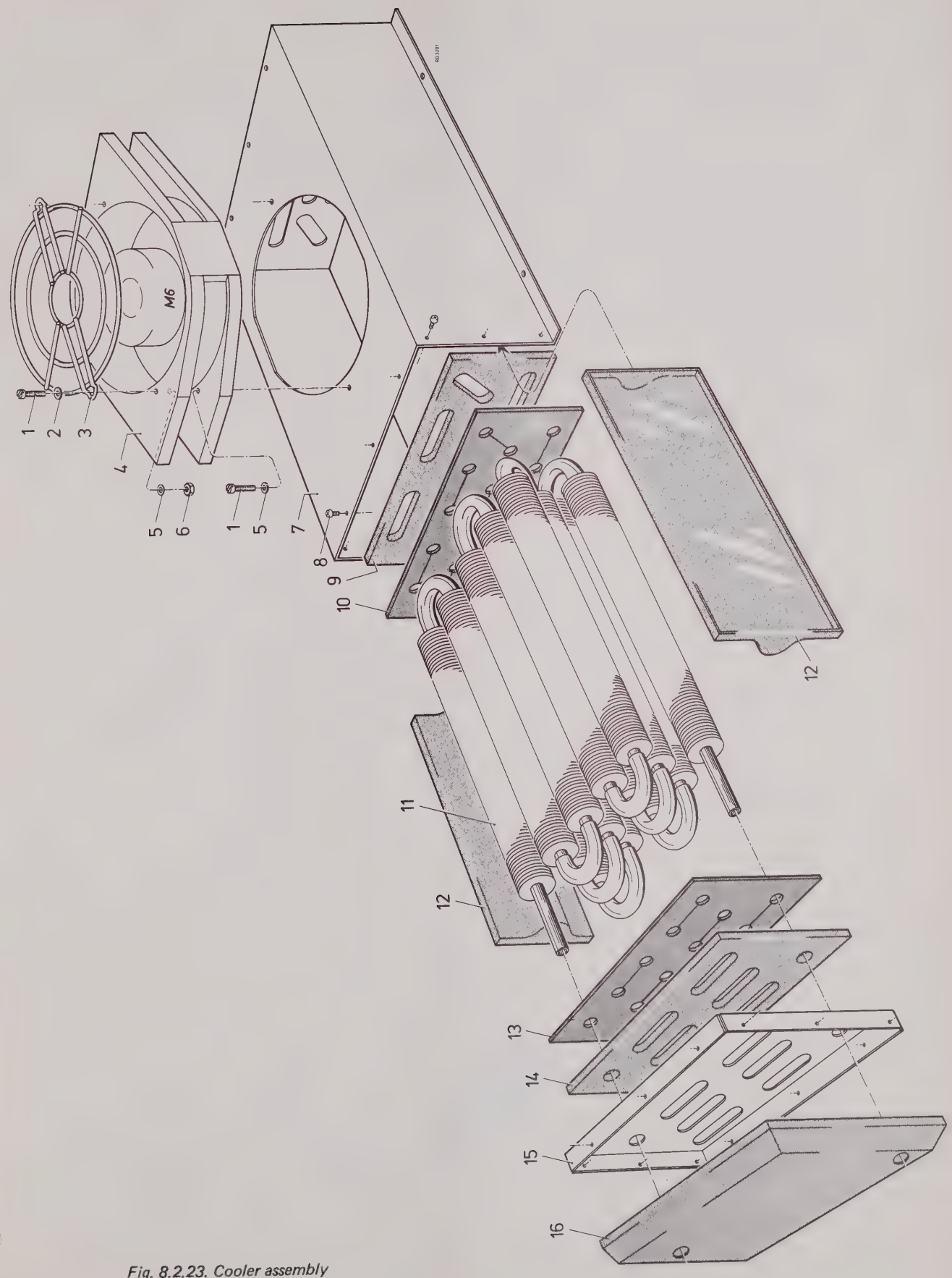


Fig. 8.2.23. Cooler assembly

8.2.24. Heater assembly up to DY1050

Item	*Description*	*Ordering code*
4	Heater element	5322 259 30103
25	Thermal cutout	5322 282 20065
30	Connector block 3-pole screw type	5322 290 64155
7	See cooler assembly	

8.2.24.a. Heater assembly starting with DY1051

Item	*Description*	*Ordering code*
	Heater element	5322 694 14582
	Thermal cutout	5322 582 50004

8.2.25. X-Ray on lamp unit

Item	*Description*	*Ordering code*
1	Cap	5322 447 94601
5	Lamp 6 V 5 W BAYONET FITTING 2 base contacts	5322 134 44197
10	Tuchel connector 4-pole	5322 264 44007

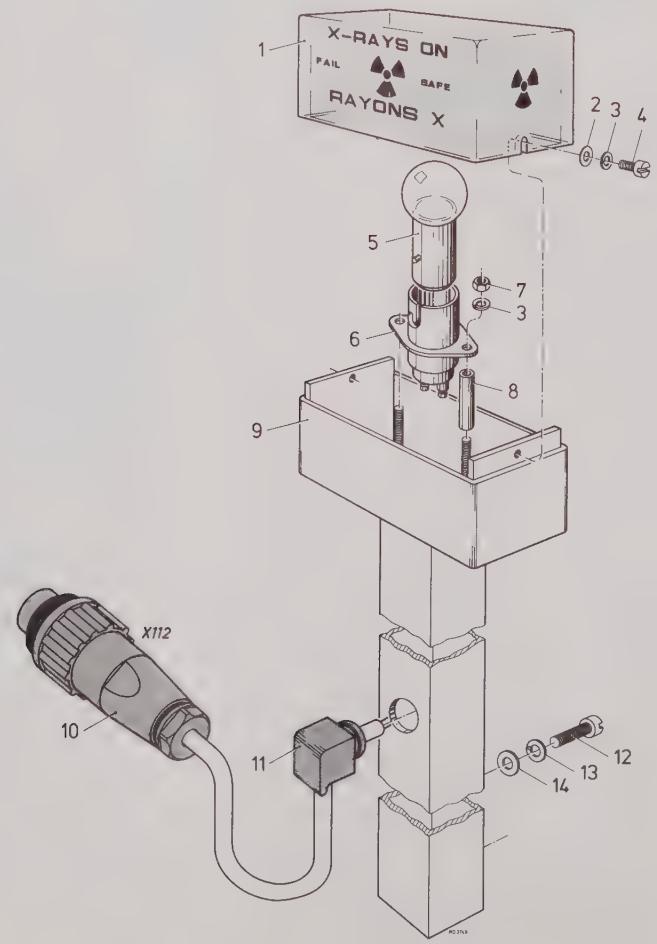


Fig. 8.2.25 X-Rays on lamp unit

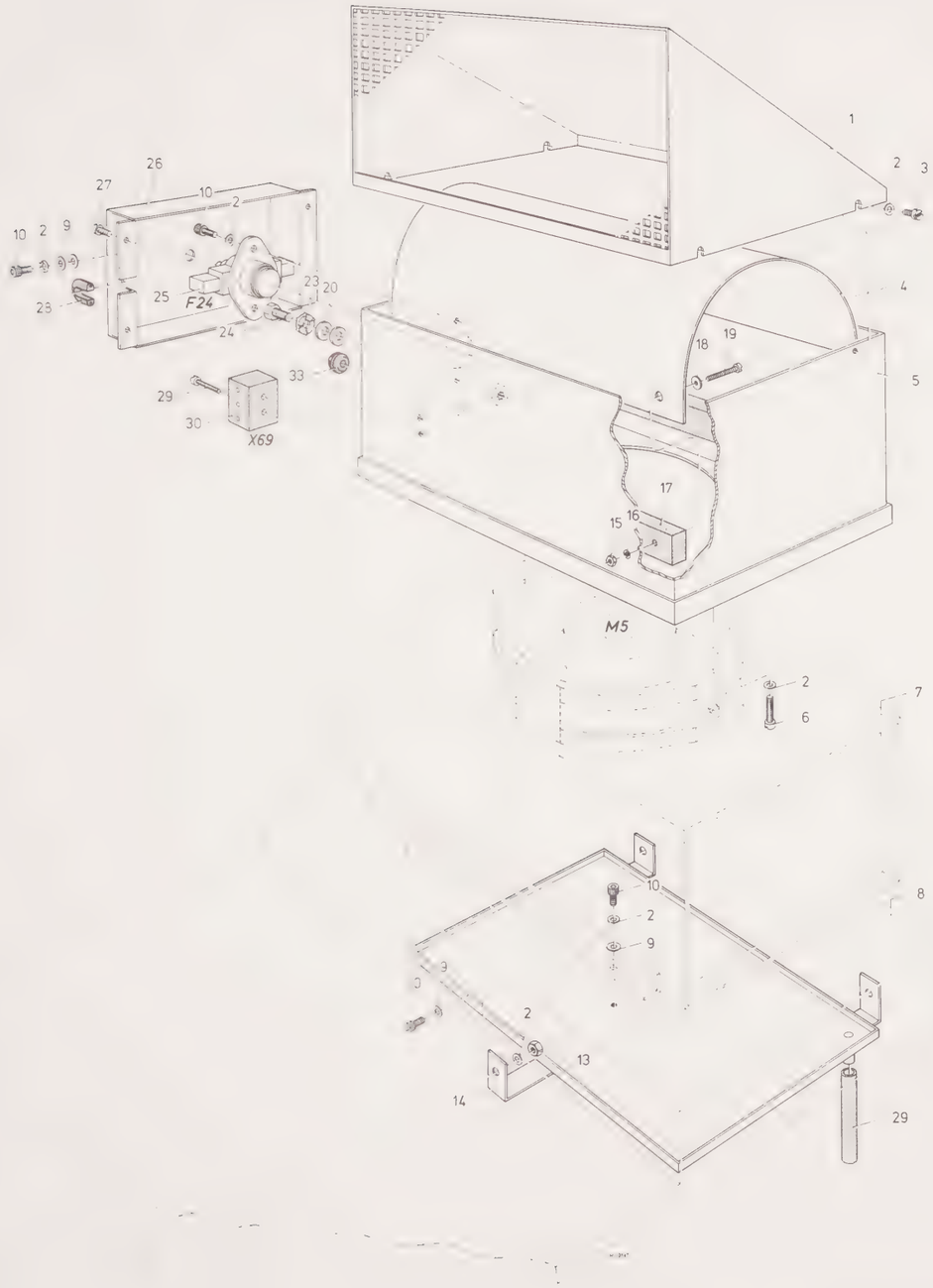


Fig. 8.2.24. Heater assembly

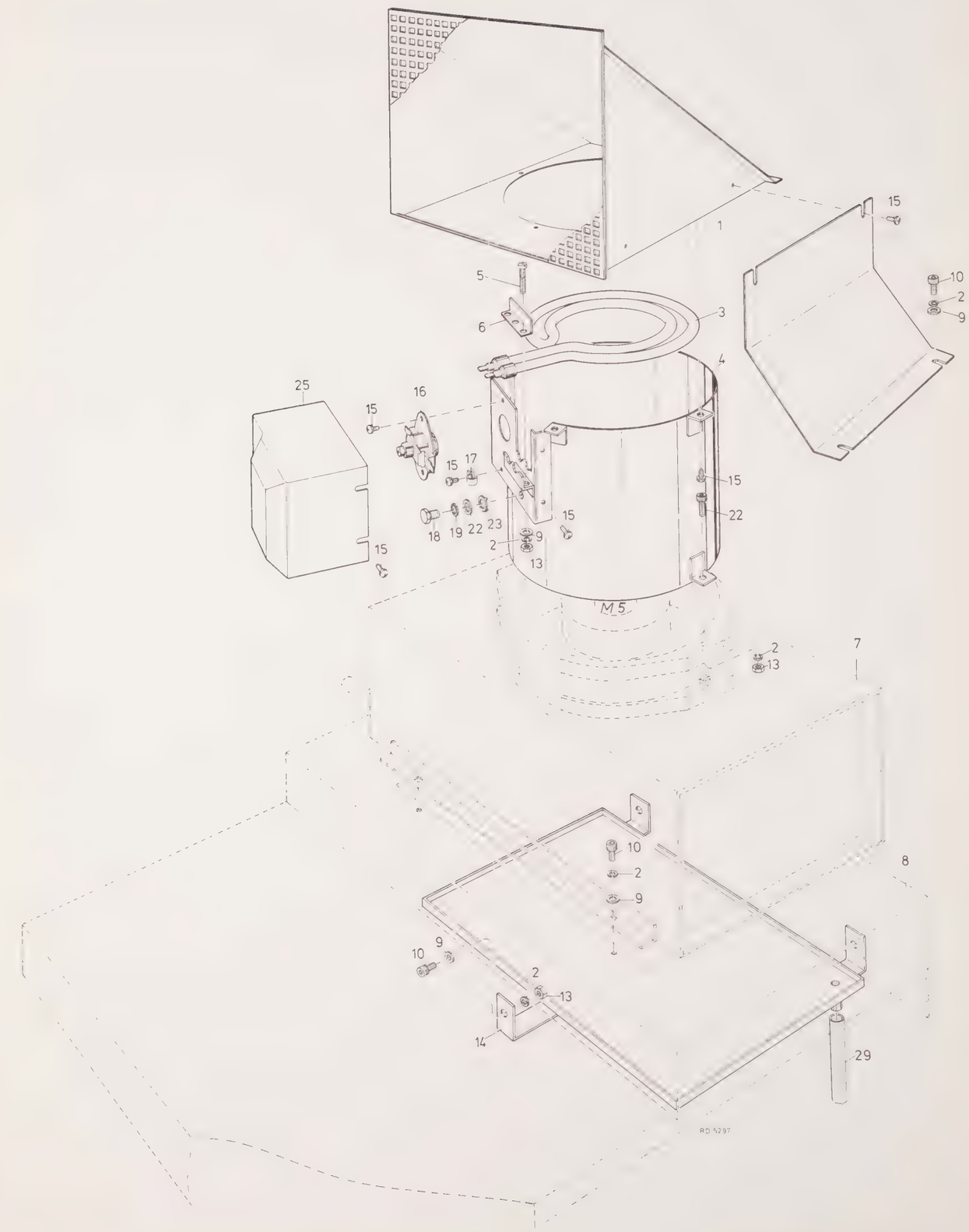


Fig. 8.2.24a. Heater assembly

8.3. HELIUM SYSTEM PW 1464/50

Item	*Description*	*Ordering code*
1	Sealing washer	5322 532 54434
2	Reduction valve	5322 360 50271
3	Reduction valve	5322 360 50269
4	Hose connector	5322 526 44195
23	O-ring, Gaco R3275	5322 530 54335
24	Neoprene hose 11 x 5	5322 530 24052
28	Nipple 8 x 0,25 in	5322 526 44156
29	Sealing plug	5322 526 44046
34	O-ring, Gaco RMD265-30	5322 530 54574
35	Coupling piece	5322 526 44198
36	Vacuum valve	5322 360 54062
40	Hose coupling, 0,125 in	5322 526 44169
43	Adapter 0,25 x 0,375 in	5322 526 44194
45	Hose connector	5322 526 44045
49	PVC hose 10 x 7	5322 530 20236
50	Elbow union 8 x 0,25 in	5322 526 44193
53	Connecting block	5322 290 84046
56	Needle valve	5322 360 54063
57	Flowmeter for helium	5322 349 24011
63	Electromagnet coil 24 VDC	5322 281 64168
64	2/2 valve, Herion 92020-00-00000	5322 360 54004
65	T-piece	5322 526 44197
66	T-piece	5322 526 44196
75	3/2 valve, Herion 9340 7-21-0000	5322 281 24015

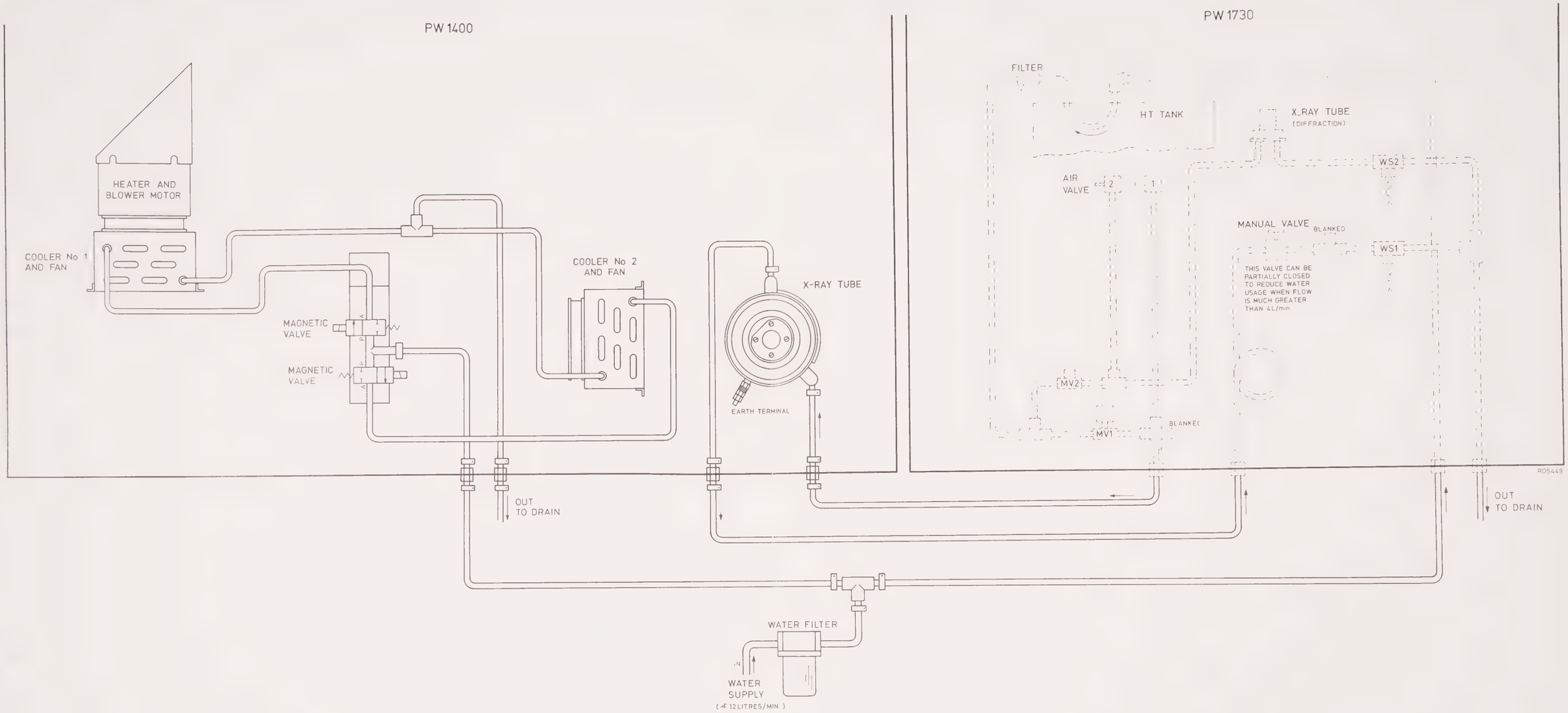


Fig. 3.11.1.a. Water supply connections
From DY1100 onwards

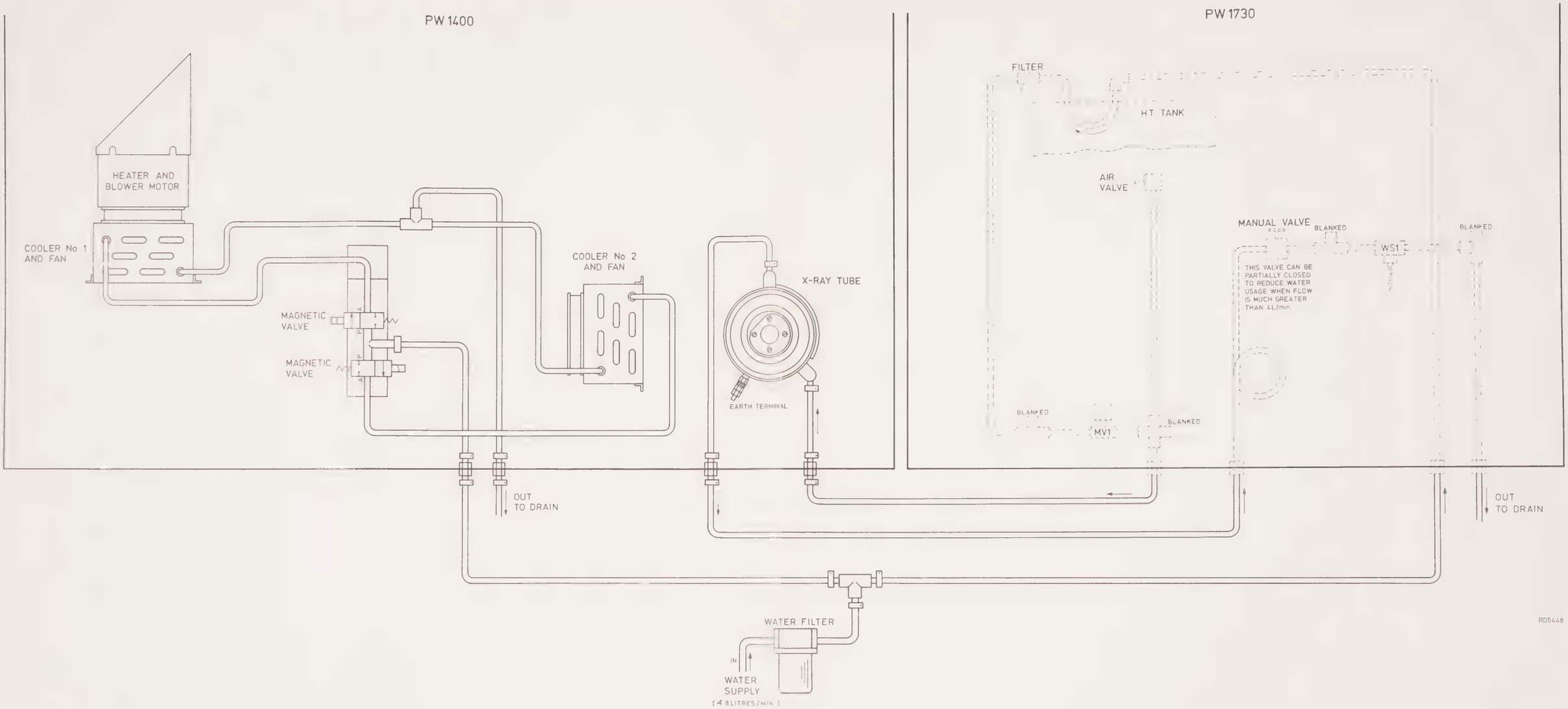
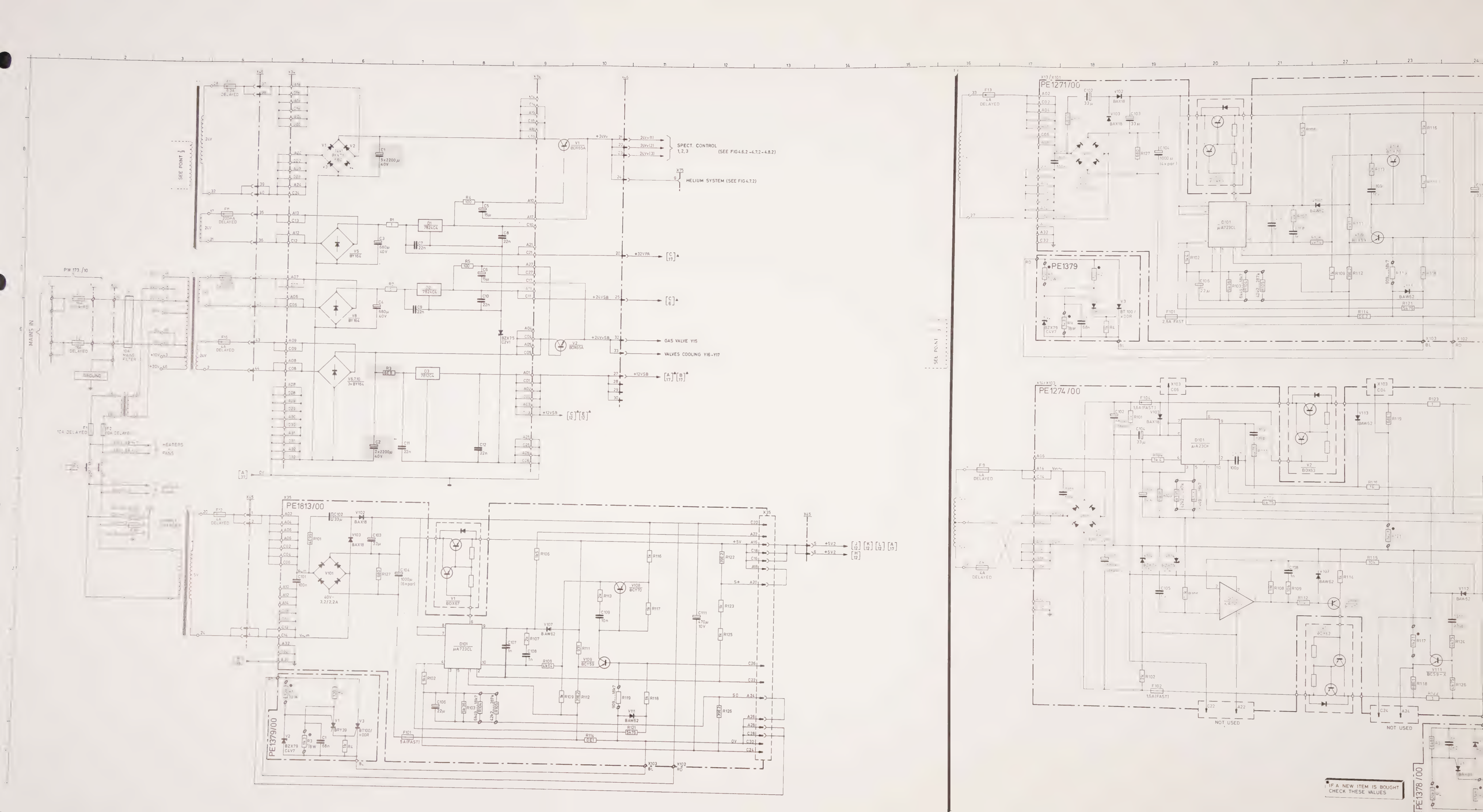


Fig. 3.11.2.a. Water supply connections for simultaneous operation From DY 1100 onwards


MAINS IN
PW 173 /10
SEE POINT 3
SEE POINT 4
F1 10A DELAYED
F2 10A DELAYED
F3 3.15A DELAYED
F4 1.25A DELAYED
F5 4A DELAYED
F6 4A DELAYED
F7 4A DELAYED
F8 4A DELAYED
F9 4A DELAYED
F10 4A DELAYED
F11 4A DELAYED
F12 4A DELAYED
F13 4A DELAYED
F14 4A DELAYED
F15 4A DELAYED
F16 4A DELAYED
104 MAINS FILTER
GROUND
HEATERS
FANS
V1 BOX65A
V2 BOX65A
V5 BY164
V6,7,10 3x BY164
V8 BY164
BZX75 C2V1
SPECT. CONTROL 1,2,3
(SEE FIG 4.6.2 - 4.7.2 - 4.8.2)
HELIUM SYSTEM (SEE FIG 4.7.2)
+32VPA
+24VSB
+24VxSB
+12VSB
+12VSB
GAS VALVE Y15
VALVES COOLING Y16 - Y17
PE1813/00
PE1379/00
PE1271/00
PE1274/00
PE1378/00
D101 μA723CL
C101 μA723CL
V1 BOX65T
V2 BOX63
V101 40V 3.2/2.2A
V102 BAX16
V103 BAX16
V107 BAW62
V108 BCY70
V109 BCY59
V111 BCY59-X
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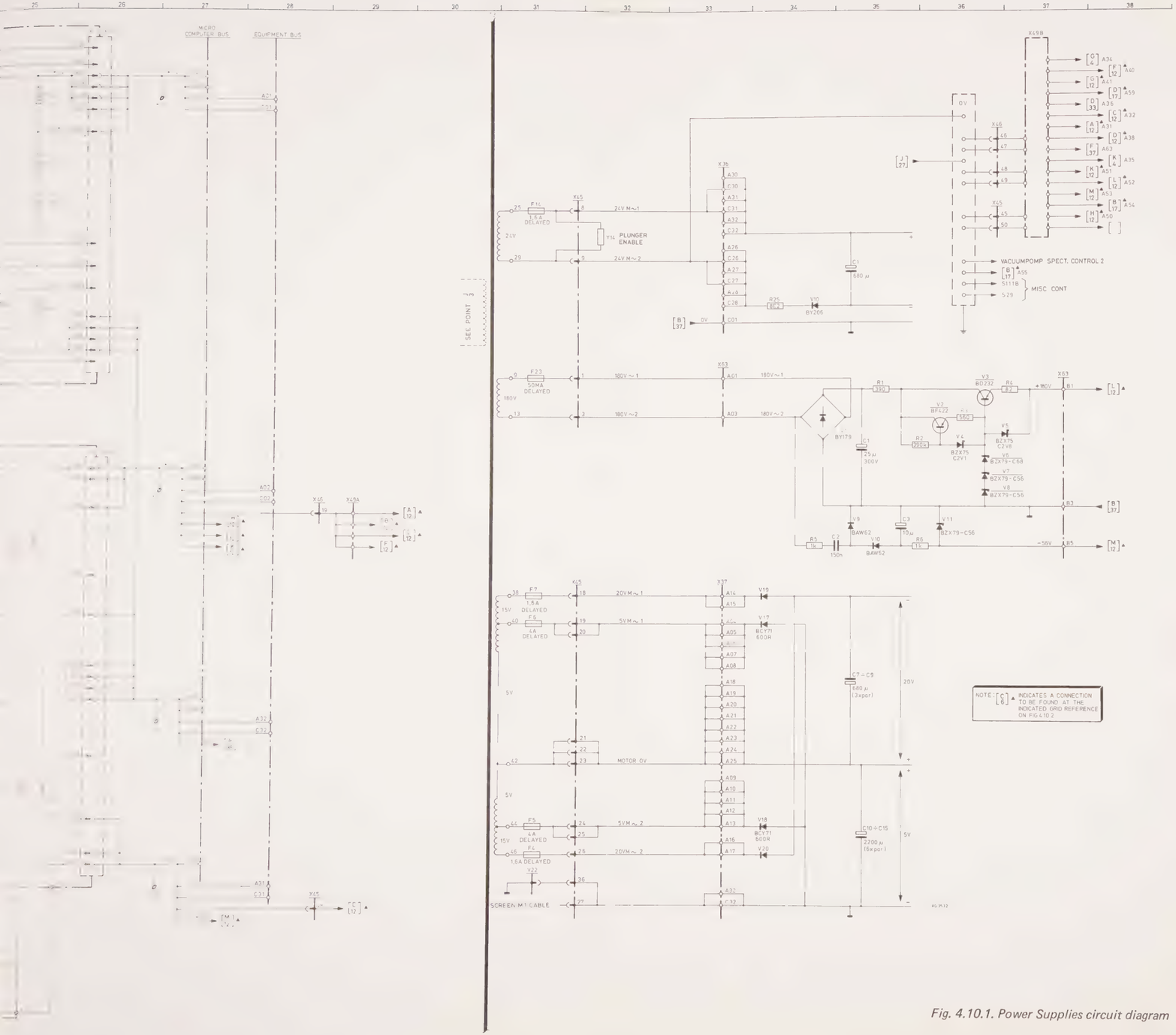

Fig. 4.10.1. Power Supplies circuit diagram

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Industrial Automation
Advanced Automation Systems
Welding

Scientific & Industrial Equipment Division

830214 | PW1400/00 | XRA203

Action Required:

Replace firmware (microprocessor)

Already issued:

XRA141, 142, 150, 153, 157, 161, 162, 164, 167, 169, 178, 179, 180, 181, 183, 189, 196, 198, 200, 201, 202.

Product: PW1400/00 microprocessor, version 2.1.

Medium: PROM

NOTES: 1. Copies of this new release for existing customers can be ordered through:

Mr. B. Oude Lansink
S&I Logistics
Nederlandse Philips Bedrijven B.V.
Lelyweg 1
7602 EA Almelo
The Netherlands.

Ordering code: *9430 900 85401*

Price: *Free of charge (we will charge when V2.1. is shipped, and credit you when the old PROM is returned).*

Please specify on your order the customer name, and the spectrometer serial number.

2. *The new microprocessor software version has to be introduced in all equipments. Units with a serial number higher than DY1025 are delivered with the new microprocessor version 2.1.*

3. *The modified software (version 2.1.) is arranged to operate with the software programs (PW1502/00 or PW1502/40) which are necessary when a Philips or a Herzog sample changer is installed with the PW1400.*

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GENERAL DESCRIPTION OF THE MODIFICATIONS

1. **The software version number typed during the switch-on (or reset) of the software is "VS2.1".**

2. **Possible deadlock situation if a slash and c.r. is typed during the evacuation of a sample in the airlock.**

If a command is typed that results in the loading of a sample (e.g. SLP, SMP. SMX), and vacuum is then selected after the cap has gone down, and before the plunger goes down, there is a time (typically 3 ... 25,5 sec.) where the "airlock" is evacuated.
If, during that time a slash (plus c.r.) is typed to abort the requested action, a deadlock situation occurs where neither the cap or the plunger can be moved.
This situation cannot be cleared, by the software, and even by a "reset" (the red button).
The only way to remove the deadlock was to switch off/on the mains power (then the error was automatically removed).
Another way was to use a special sequence of "TST"-commands.

The software is now changed so that the abort action which is given by a slash and c.r. is delayed until the complete cap/evacuation/plunger cycle (for loading or unloading) is completed.
The slash and c.r. can still be typed at any time as required.

3. **Possible deadlock situation with a P-800 series Philips minicomputer connected to the PW1400**

If the transmission of information from the PW1400 microprocessor to the minicomputer goes too fast for the mini, the handshake lines can be used by the mini to suspend the transmission from the micro. This works quite well in the DEC PDP-11.
The interface-card in the Philips minicomputer however does not work too well in the full duplex mode, it can only switch the handshake lines when it is in the transmit-mode.
To give the mini the time to switch from the receive mode to the transmit mode, and not losing characters, there is a delay of 100 milliseconds after each line of output from the PW1400, during which time the mini can carry out the action.
An output line is defined as a string of characters ending with a carriage return, so after each carriage return there should be a delay.

This delay was not implemented in an "empty line" (l.f. c.r. only) which is transmitted before (!) "C=" and error-messages.
This resulted in the possibility that with long messages, and mostly when a (slow) printing device was used as the operators terminal for the mini, there could occur a deadlock situation.
If the mini is switched from receive to transmit just after the carriage return before the C=, the "C=" characters sent by the PW1400 were missed, and the PW1400 carries on waiting for the characters.

In the new micro-software this delay is now given after **each** carriage return is transmitted.

4. **Error in scan length on the recorder paper**

If during a continuous scan a diagram is written by the recorder, the length of this scan, measured in time, is about 0,2 seconds too long.
With the maximum recorder speed of 8 cm/minute this is about 0,3 mm of chart length. Additionally this error is cumulative, so that after a few scans the recording is visibly too long.

In the new software this 0,2 second error is removed.

5. "** ERROR BATTERY, PARAMETERBANK CLEARED",without battery error

Sometimes, when the power of the PW1400 is switched off, the power-down reset for the microprocessor does not work properly. This can result in erroneous information in the RAM.

In many cases most of the CPU time is spent on testing status words in the RAM (e.g., in C= mode and during measurement).
If a faulty power-down occurs, this reading of specific RAM addresses can affect the writing (!!!) to (other) addresses. In most cases this is only in the "scratch" area, but sometimes real information is destroyed.
When the PW1400 is powered up again there is a test of the validity of (some) RAM addresses, and if these are changed the software assumes this is due to an improper battery, clears the RAM and generates the error-message: "** ERROR BATTERY, PARAMETERBANK CLEARED".

In the new software the two most executed "wait-loops" (C = / measurement) are not executed continuously, but the processor is put in a "HALT", from which it is wakened by each interrupt. This happens after at least each 100 milliseconds, and with each keyboard input.

If the power is switched off when the processor is in a "HALT" situation there is no erroneous writing to the RAM. The error rate is improved by 100 ... 1000, and is not detectable any more.

6. USART restartable without hardware reset

When the microprocessor starts (at address 0000 H) one of the first actions is to program the USART's (serial I/O chips) for baud rate, parity, etc.
In the method selected this programming must be preceeded by a hardware reset, as is done with "power off/on", or the "reset-button".
If the software was (re) started by means of a "TST E 0000" command; or a "jump 0000" in a test program, this hardware reset was not present and the programming of the chips went wrong and there was no communication with the operators terminal any more.

In the new software version another method is chosen to progam the USART's, and the hardware reset is not required any more.

7. "Test bus" test command ends with all output lines low instead of high

If a HERZOG sample changer/loader is to be connected to the PW1400, there is a test possibility to check the "PHILIPS" part of the installation.
The delivered short-circuit plug can be used to connect all the output lines from the sample changer interface card in the PW1400 to all the input lines (can be done on the sample changer connection plug).
With the command "TST B C080 C080 FF" the micro-processor now automatically tests the interface card and the cabling.
However, after the test all output-lines are "high", and if without switching the PW1400 off, the HERZOG sample changer is connected, all functions of the changer are activated at the same time. This was not an acceptable situation.
By using the test command "TST W C080 00" this situation could be corrected.

In the new software the test is changed in such a way that after the test all output lines are "low".

8. **Switching from a 72-position sample changer to a 6/12 position loader could result in a deadlock situation**

In the rare situations were a PW1500/15, /16 (72 position) is replaced by a PW1500/05, /06 (loader) there could be a deadlock situation where the software waits for the depression of a microswitch which is not present in the loader.

The test command "TST W 40D5 00" could solve this problem.

In the new software this problem is solved in the "start-up" procedure, so that it is automatically done at power on (or "reset")'

9. **Ratemeter selection after power on**

If the PW1400 starts up, the ratemeter (RMS) was not selected by the software, nor by the hardware, and thus was random. This could also result in an erroneous display of the ratemeter setting.

The software is modified now so that the RMS after power up will be the same setting as it was when the power was switched off.

Only for the first time, and after an "** ERROR BATTERY", the selection will be "manual" (not user selectable !).

10. **Improvement of the KVM - instruction**

Generator "MANUAL" can be selected by the operator of the PW1400 if a zero is typed for one, or both of the two arguments in the "KVM kV, mA" - instruction (e.g., "KVM 30,0" or "KVM 0,0").
If a valid kV value was typed and the mA value was not typed (e.g. "KVM 30"), then the microprocessor assumes mA=0, thus resulting in the selection "MANUAL". This should be avoided if the generator is already set at a high kV and/or high mA value.

The KVM instruction is now changed so that an error-message is generated ("** INVALID ARGUMENT"), and the previous kV, mA setting is not changed.

11. **Removal of "dead-code"**

There existed a small part of a so-called "dead-code" i.e. a code that is not used any more, but is still present in the memory. (This had no external effects).
This is now removed.

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830429 PW1506/00 XRA 205

SERVICE INFORMATION

Already issued: XRA 161 AND 195 (PW1500/05/06).

Action: Fit the spring clip that is delivered with all PW1506/00 12 Position Sample Changers. The function of the spring clip is to keep the tray parallel to the front of the loader when the tray is moved to the extreme left position.

Fitting Instructions: The spring, shown in figure 3, has to be mounted on the side of the cap item 2 in figure 1. The dimensions of the cap are given in figure 2. If the two holes in the cap shown in figure 2 are not there, they must be drilled out. There may be a lip on the side of the cap, if there is one, it must be filed off.

Figure 4 shows the location of the spring clip when fitted to the detection cap.

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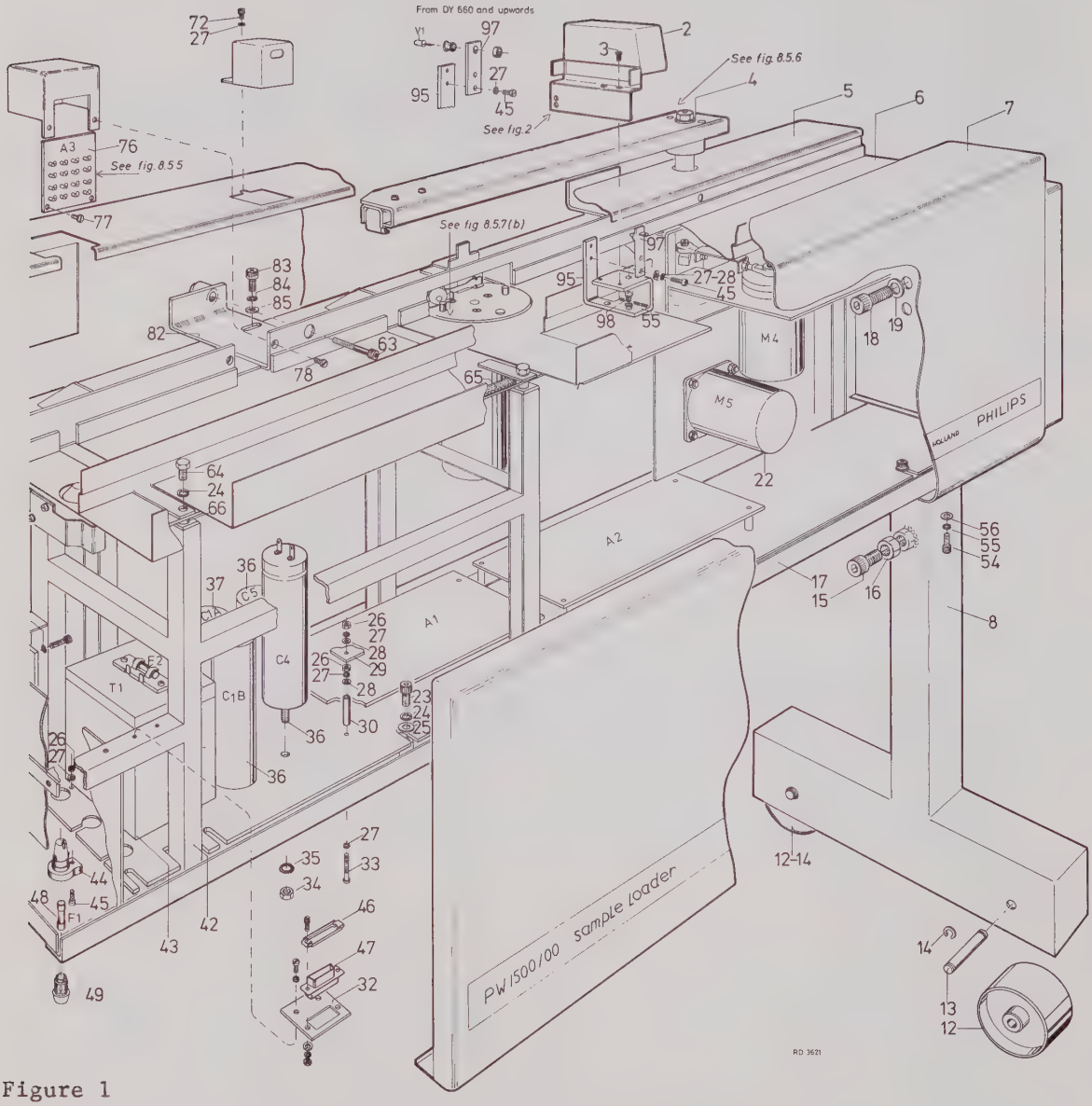
From DY 660 and upwords
See fig. 8.5.6
See fig. 2
See fig. 8.5.5
See fig. 8.5.7(b)
PW1500/00 Sample Loader
PHILIPS
HOLLAND
RD 3621

Figure 1

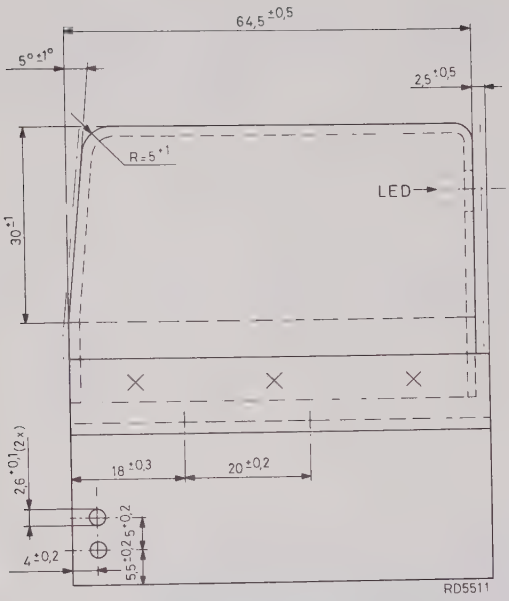

Figure 2

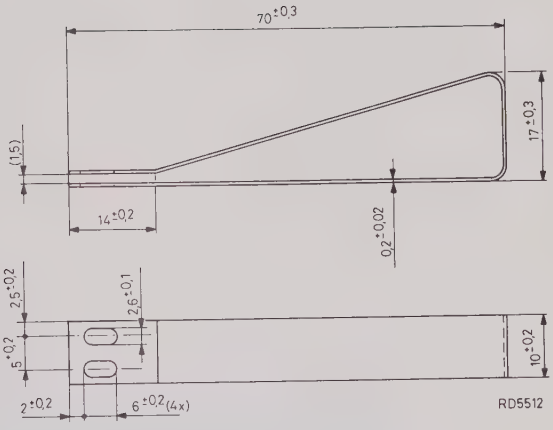

Figure 3

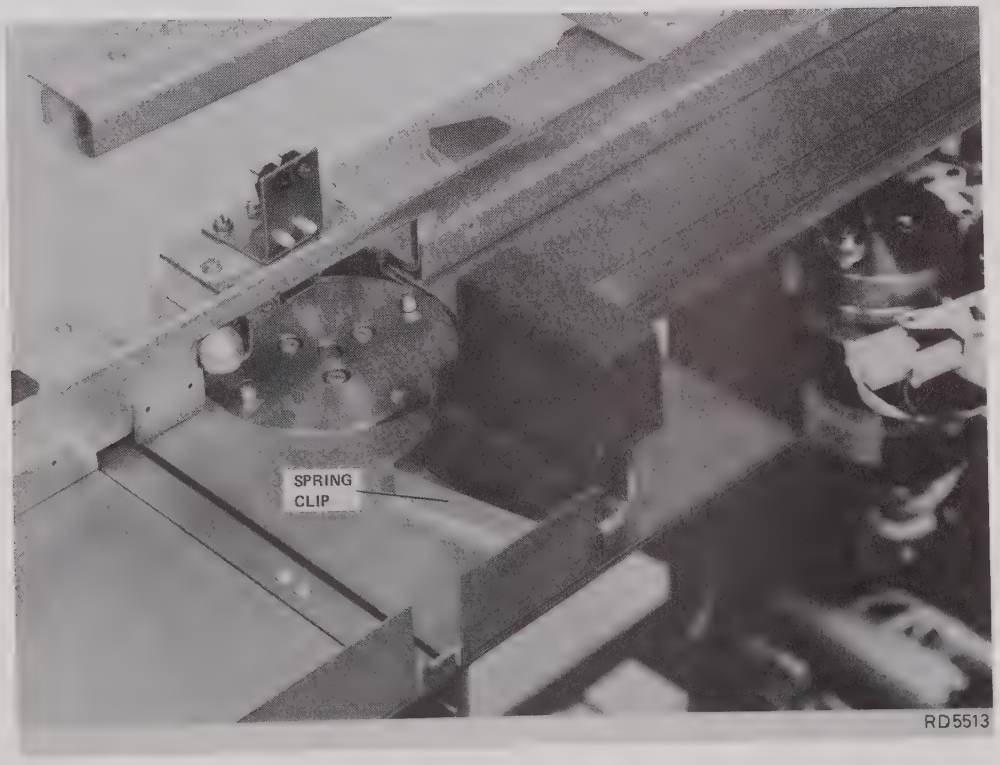

Figure 4

X-ray Spectrometer system
PW1400

Service Manual (Edition 2)

9499 305 05511
811027

RD 3537

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ERRATA

During the printing of the manual several errors were found.
The following corrections should be made by hand to correct these:

Page 4-115

Fig. 4.3.3.3. Grid reference G/1

On connector X20A change "C28 RESIN" to "A28 PON+"

Grid reference H/15

On the USART change "RESIN" to "PON+". Change the symbol for the USART so that it is the same as that shown on page 4-50.

CONTENTS OF PW1400/00 SERVICE MANUAL

1. INTRODUCTION

2. SPECIAL PRECAUTIONS

3. INSTALLATION PROCEDURE

4. ELECTRICAL DESCRIPTION

5. MECHANICAL DESCRIPTION AND ADJUSTMENTS

6. PREVENTIVE MAINTENANCE

7. TEST AND TEST METHODS

8. ILLUSTRATED PARTS LIST

9. APPENDIX A

10. APPENDIX B

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1.1. X-Ray spectrometer PW1400/00 1-1

1.2. Use of the manual 1-1

1. INTRODUCTION

1.1. X-RAY SPECTROMETER PW 1400/00

The X-ray spectrometer PW 1400/00 can be used for the identification and quantitative analysis of all elements from the heaviest down to atomic number 9, fluorine.

It is designed to be used in conjunction with an X-ray generator of the PW 173 . / . . series, which provides both high voltage and current for the X-ray tube. A 6-position sample loader type PW 1500/05 (50 Hz) or PW 1500/06 (60 Hz), or a 72-position sample changer type PW 1500/15 (50 Hz) or PW 1500/16 (60 Hz) can be fitted as options, as can a chart recorder type PM 8203. The sample loader and sample changer are fully described in this manual, together with their installation and adjustment procedures. Before the introduction of the aforementioned versions of the sample loader and sample changer the versions PW 1500/00 and PW 1500/10 were available. These versions were supplied for universal 50/60 Hz use. The differences between the versions are small and are described in the manual.

A helium system PW 1464/50 is also available as an option. The electrical wiring and compressed air connections for the helium system are fitted as standard in the spectrometer, so that fitting the system requires a minimal amount of work. The helium system is fully described in this manual, together with the installation and adjustment procedure.

The spectrometer is operated via the keyboard of a VDU (Video Display Unit), eg. P817 or a teletypewriter, eg. PC 1409/01. These peripherals can be connected directly to an interface in the spectrometer, or to a mini-computer eg. PW 1790/11, which is in turn connected to an interface in the spectrometer. No other means of operating the spectrometer is provided.

The spectrometer is provided with a temperature stabilization system which has both heating and cooling elements and which requires a supply of cooling water, either from the mains or from a separate water cooler. The cooling system can be connected in series with the cooling water supply for the X-ray tube provided a simultaneous arrangement is not installed.

The spectrometer can be connected to operate simultaneously with a diffraction set using the same X-ray generator. In this arrangement the high voltage must be the same for both X-ray tubes, although the tube currents may be different. Also, for simultaneous operation two separate cooling water supplies are required.

1.2. USE OF THE MANUAL

This manual is primarily intended for service engineers, and contains technical descriptions of the electronic and mechanical parts of the spectrometer, the procedure to be followed during installation, details of the adjustments necessary for optimum operation, performance tests, and an illustrated list of available spare parts. It is intended to be read in conjunction with the operating manual, which gives a full account of all the operating commands and computer programs.

Throughout the manual terms such as right, left, front, rear, upper, and lower are used to identify parts of the spectrometer or to describe operations or procedures. These terms relate to the position of an observer who is facing the front of the spectrometer unless a specific statement is made to the contrary in the relevant part of the text.

The manual contains certain items which require special attention. These items are sometimes given in boxed paragraphs of less than the normal text width and are headed either WARNING, CAUTION or NOTE. When these headings are used they have the following meanings:

WARNING — Denotes information which, if disregarded, may result in danger to the health or safety of the service engineer, the operator, or of other persons in the vicinity.

CAUTION — Denotes information which, if disregarded, may result in damage to equipment, excessive wear, or unsatisfactory equipment performance.

NOTE Dênotes information of particular importance for the understanding or the adjustment of the spectrometer.

The manual is arranged in sections covering the various aspects of the equipment, and where appropriate, each section has an introduction which explains its structure and use and contains definitions of the terms and symbols used.

In the manual the spectrometer is described as though all the available accessories were fitted. Where this is not the case the appropriate passages in the text must be disregarded. Where alternative equipment configurations are possible, all such configurations are described.

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2. SPECIAL PRECAUTIONS

2.1. INTRODUCTION

This chapter is intended to provide information on the precautions to be taken in some situations to avoid in jury to persons or damage to equipment. It should not be assumed that the information here given is necessarily complete, and while every effort has been made to list the necessary precautions to be taken, there is no substitute for careful working and the exercise of common sense.

2.2. IONIZING RADIATION

The PW 1400/00 produces ionizing radiation internally. Exposure to this radiation can be dangerous to health. However in normal use the spectrometer is provided with protective shielding which effectively prevents any significant level of radiation from escaping.

The following precautions must be observed when the spectrometer is being adjusted or serviced.

1. All repair, adjustment, or alignment must be carried out under a strict scheme of work approved by an authorized person or board where this is a requirement in the country where the equipment is installed. In this case such a scheme must be part of the relevant local service instructions.
2. Always check the condition of the equipment on arrival.
3. Reinstall each and every safety device before energizing the equipment.
4. Make a check of each and every overriding or manipulation of safety devices so that these can be checked again during reassembly.
5. Never operate the equipment in a disassembled condition with overridden safety devices.
6. Whenever necessary to do so, make sure that the power selection (kV and mA) is the lowest possible and only perform adjustments etc., while constantly monitoring the radiation levels.
7. Be constantly alert not to endanger persons in the vicinity. You are responsible.
8. Never operate the X-ray tube at over 60kV if any of the protective shielding is removed or if any of the outer covers is removed.
9. Always replace all the protective shielding after the spectrometer has been serviced or adjusted.
10. Never adjust the crystals unless the protective transparent crystal chamber cover is in position.
11. The primary collimator must be aligned without a cover being fitted to the crystal chamber. Always use the special hexagonal "T" key provided for this adjustment and take care never to put the hands into the crystal chamber while X-rays are on.
    Always switch off the generator before loosening or tightening the locking screws on the collimator adjusters.
12. Always perform a safety check after finishing the job and show the client that the machine is being handed back in a safe condition.
13. Ensure that the client signs for this final safety check.

2.3. HIGH VOLTAGES AND LEAKAGE CURRENTS

1. All the major units in the PW 1400/00 system have high leakage currents. It is essential that the units be correctly earthed before being connected to the electrical mains.
2. All the units in the PW 1400/00 system have mains voltages (220 V_{ac}) present. The terminals carying these voltages may be exposed when the covers are removed.
3. The X-ray generator and the X-ray tube (and the connecting cable) may have up to 100kV present. Always ensure that the safety circuit is working correctly before disconnecting parts associated with these voltages. Never defeat the safety circuit if parts carrying high voltages must be opened or disconnected.
4. Never remove the high voltage connectors to the detectors with the high voltage present as this can cause damage to the preamplifiers.
5. The voltage on the H.T. cable connected to the X-ray tube decays slowly to zero when the generator is switched off. Always wait two minutes after switching off before disconnecting the cable, and as an additional precaution always touch the central point of the HT connector to an earth point on the spectrometer each time it is disconnected to ensure that the HT capacitor in the generator is fully discharged.

2.4. VACUUM SYSTEM

If the vacuum in the spectrometer is released too rapidly, the sudden rise in pressure can rupture the window of the gas flow detector or the crystal chamber. This can happen if the special crystal adjusting screwdriver is withdrawn from the transparent crystal chamber cover. Always choose an air atmosphere or open the air inlet valve on the sample chamber (vacuum pump off) before removing the screwdriver.

2.5. PNEUMATIC SYSTEM

The spectrometer is fed, via a reduction valve, with compressed air at a pressure of 4 atmospheres. This can be dangerous if it is allowed to enter any body orifice.
Always handle compressed air lines with care.

2.6. GAS CYLINDERS

The detector gas and helium gas are supplied in cylinders pressurized to 150 atmospheres. These cylinders can be dangerous if allowed to fall. Always ensure that gas cylinders are properly secured against a wall or in an approved stand. Always follow local safety regulations with regard to the placing and securing of gas cylinders.

2.7. CARE OF ANALYSING CRYSTALS

Crystals are delicate and expensive parts, and must be handled with care. Their efficiency can be maintained by taking the following precautions:

1. Most crystals are hygroscopic and absorb water from the atmosphere, therefore
   (a) Never put a crystal into the spectrometer unless it is absolutely dry. Evacuating a crystal which contains water can cause it to be destroyed.
   (b) Always store unused crystals in vacuum (e.g. under a belljar), in a desiccator, or in a hermetically sealed container with a desiccant (e.g. silica gel).
2. All crystals are delicate-handle them with care. Always hold them by the edges of the aluminium support.

3. The crystal TLAP contains the toxic element thallium. This crystal is soluble in water, and can poison by skin contact. Always handle with extreme care, avoid skin contact, and after handling it wash the hands thoroughly before eating or smoking.

4. No guaranteed method exists for cleaning analysing crystals. Cleaning should only be attempted as a last resort when a point has been reached where the efficiency of the crystal has become so low that the choice is between trying to clean it and throwing it away. The following method has sometimes been successful:

   Place two pieces of lint-free cloth, folded to give several thicknesses on a flat surface. One piece should be damped with a solvent and the other should be dry. Wipe the surface of the crystal quickly over the damp cloth and then over the dry one, several times in succession.

   The following solvents can be tried:

CRYSTAL	SOLVENT	REMARKS
ALL	water	TLAP is soluble in water
LIF200, LIF220	Trichlorethylene	
Ge		
PE, TLAP	Petroleum ether	
KAP, RAP		
Graphite, Gypsum	None	Use dry cloth only.

   Remember the results of cleaning cannot be guaranteed.

2.8. USE OF MICROPROCESSOR TEST COMMANDS

When microprocessor test commands are used, any safeguards in the normal software which prevent incorrect movements or movements which occur too hard are no longer available. This means that the test commands should be used with care.

In particular, most mechanical movements involve the operation of two compressed air valves before the actuator can be moved in the desired direction (e.g. plunger, cap, collimator, etc.).

To avoid these movements taking place with too much force it is important that the valves be operated in the correct order. This always involves first opening (ON) the valve causing movement in the desired direction and second closing (OFF) the valve causing movement in the opposite direction.

For example, to lift the cap

first "Cap up on"	TSTWC02001
second "Cap down off"	TSTWC02002.

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3. INSTALLATION PROCEDURE

3.1. UNPACKING

The spectrometer is delivered in a wooden crate with the following dimensions and weight:

Height : 130 cm (including shock absorbers)

Depth : 110 cm

Width : 120 cm

Weight : 530 kg gross, 465 kg net.

Remove the top of the crate after unscrewing the bolts with which it is secured. Remove the side walls of the crate in a similar manner. This will leave the spectrometer attached to a pallet by four bolts which must be removed from the underside.

If a fork-lift truck is available, raise the spectrometer on its pallet using the four levelling screws and remove it carefully with the fork-lift truck.

If a fork-lift truck is not available, slide the spectrometer carefully from its pallet, taking care that it is not bumped or jarred in the process.

Some parts are packed separately in a cardboard box, see 8.2.1. Some of these parts must be used during installation, while the rest must be kept in a safe place for later use during maintenance visits.

3.2. PLACEMENT OF UNITS

3.2.1. General

All units of the PW 1400 system may be placed next to each other so as to form one continuous installation. For this purpose the side panels of the various cabinets can be removed. Note however that the right hand side of the spectrometer cabinet must remain accessible. The system units can then simply be placed next to each other in one line. A minimum space of 1 metre must be allowed at the back and sides of the cabinets for access purposes. The floor on which the cabinets are placed must be capable of accepting a loading of 120N/cm^2.

3.2.2. Preparation

Remove the front, back, and side panels from all the cabinets and the table top from the spectrometer. To remove the table top, first remove the two screws securing it to the top frame member at the rear, slide the table top to the rear and lift it off.

3.2.3. Leveling

It is very important that the cabinets be carefully levelled, especially the spectrometer. If the cabinets are to be installed in line, level the generator first. To level the spectrometer, place a good quality spirit level over the loading opening in the top of the sample chamber, and level the spectrometer using the four levelling screws provided (a 10 mm hexagon key is required; this is supplied with the spectrometer).
First place the X-ray generator in position and level it with a spirit level placed on the table top. This is necessary because the levelling screws at the right-hand side will later be inaccessible. Next, place the spectrometer in position and level it.
When the spectrometer has been levelled, level any other cabinets with a spirit level placed on the table-top.

3.3. SCINTILLATION DETECTOR AND AUXILIARY COLLIMATOR

Cut the cord securing the detector arm to the spectrometer frame, and remove the paper strip protecting the crystal chamber window.

Detach the scintillation detector and attach it to the detector arm. If the auxiliary collimator is to be fitted, first remove the counter weight from the detector arm and place the detector and the collimator as shown in fig. 3.3.1.

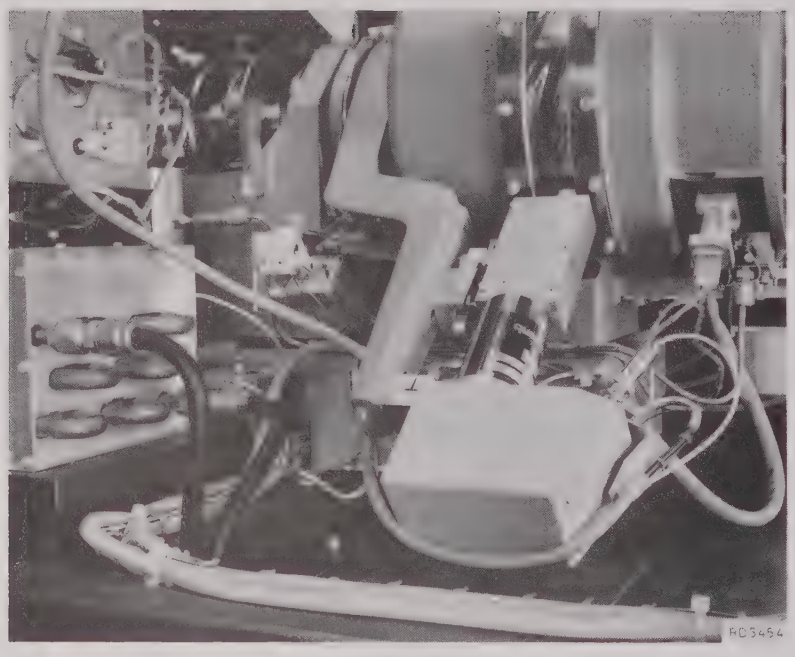


Fig. 3.3.1. Scintillation detector with auxiliary collimator

If the auxilary collimator is not to be fitted, place the detector as close as possible to the crystal chamber window, and attach the counter weight as near to the end of the detector arm as possible, as shown in fig. 3.3.2.

CAUTION

Either the auxiliary collimator or the counter weight must be fitted to maintain the detector arm in correct balance. Failure to fit one of these can lead to undue wear and poor angular reproducibility.

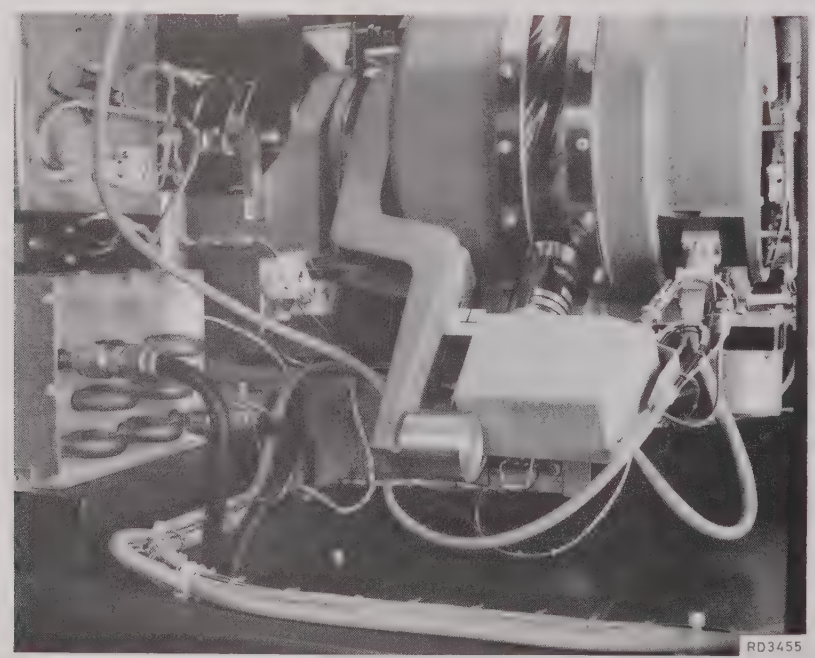


Fig. 3.3.2. Scintillation detector with counter weight

3.4. VACUUM PUMPS

3.4.1. Vacuum pumps up to and including serial number DY852

The vacuum pump is mounted on four antivibration mountings, but for transport purposes it is fixed firmly to the spectrometer frame with four bolts. Remove these bolts and check that the pump sits properly on its mountings.

The vacuum pump driving motor has a double pulley. The spectrometer is normally delivered with the driving belt in position for 50 Hz operation (see fig. 3.4.1.1.). For 60 Hz operation place the driving belt on the smaller pulley, position the pulleys so that the belt runs correctly, (see fig. 3.4.1.1.) and adjust the belt tension.

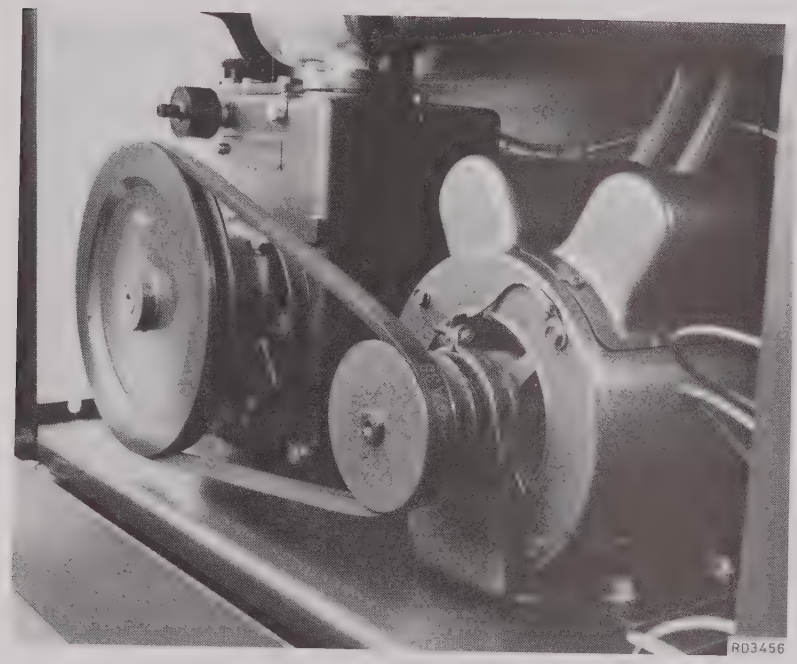


Fig. 3.4.1.1. Vacuum pump drive belt – 50 Hz operation

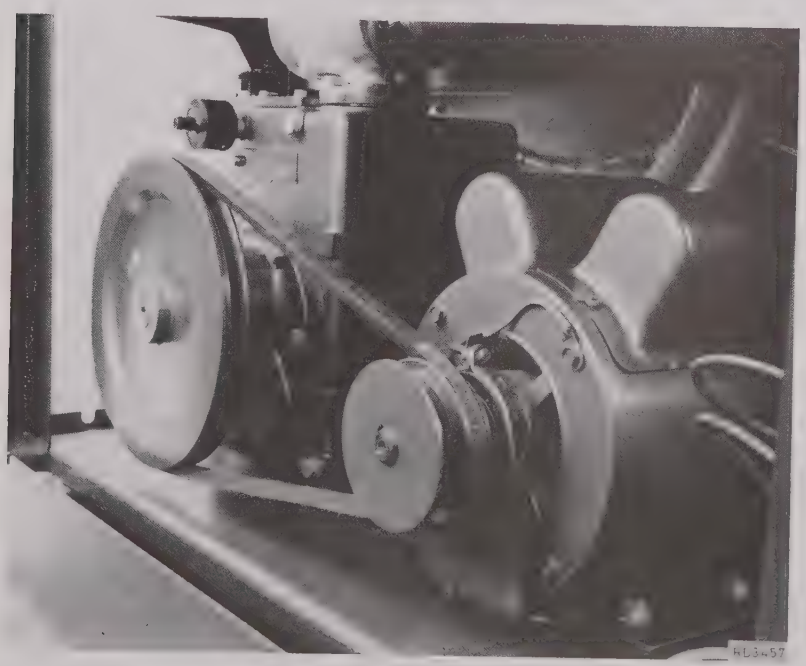


Fig. 3.4.1.2. Vacuum pump drive belt – 60 Hz operation

Fill the vacuum pump with Edwards Speedivac oil No 16 supplied until the oil level is between one-half and two-thirds of the height of the sight glass.

Open the foreline trap on top of the vacuum pump and fill the basket with aluminium oxide pellets which are packed separately in a tin, or plastic bag, (see fig. 3.4.1.3.).

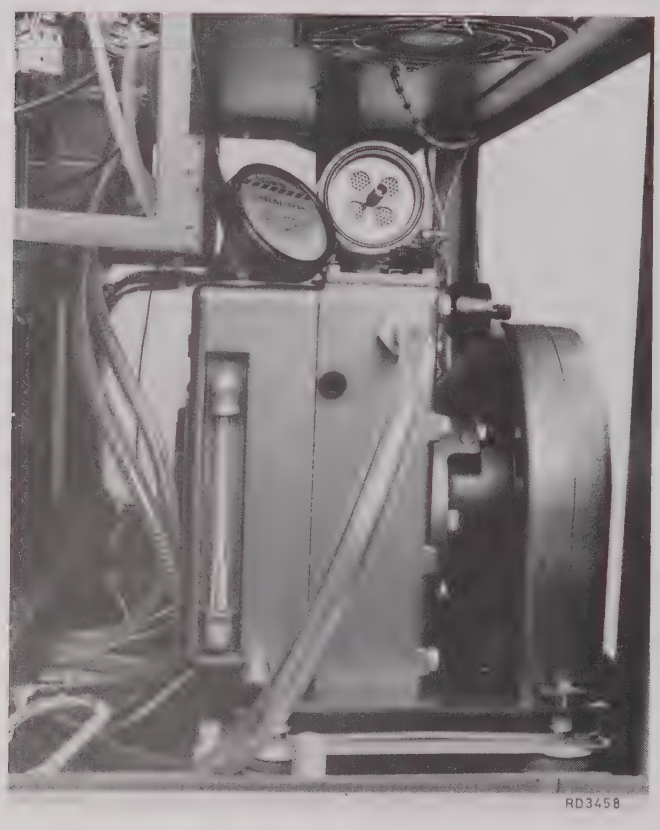


Fig. 3.4.1.3. Foreline trap

3.4.2. **Vacuum pump, starting with serial number DY853**

Starting with serial number DY853, a universal 50/60 Hz 2-stage vacuum pump, Edwards typ 18.

The pump is mounted on a base plate, to which four antivibration mountings are attached. In use the pump rests on the spectrometer buttom plate, with the antivibration mountings resting in dimples to prevent "walking" (see fig. 3.4.2.1.). For transport purposes, the pump baseplate is fixed to the spectrometer bottom plate with four transport clamps (see fig. 3.4.2.2.). Before switching on the pump, loosen the transport clamps, turn them through 90° and tighten them again to prevent them being lost.

Fill the vacuum pump with Edwards speedivac oil No 15 supplied until the oil level is between one-half and two-thirds of the height of the sight glass. After the first 100 hours of use, drain and flush the pump and refil with oil as specified in the Edwards Instruction manual deliverd wit the spectrometer.

Open the forline trap on top of the vacuum pump and fill the basket with aluminium oxide pellets which are packed separately in a tin or plastic bag.

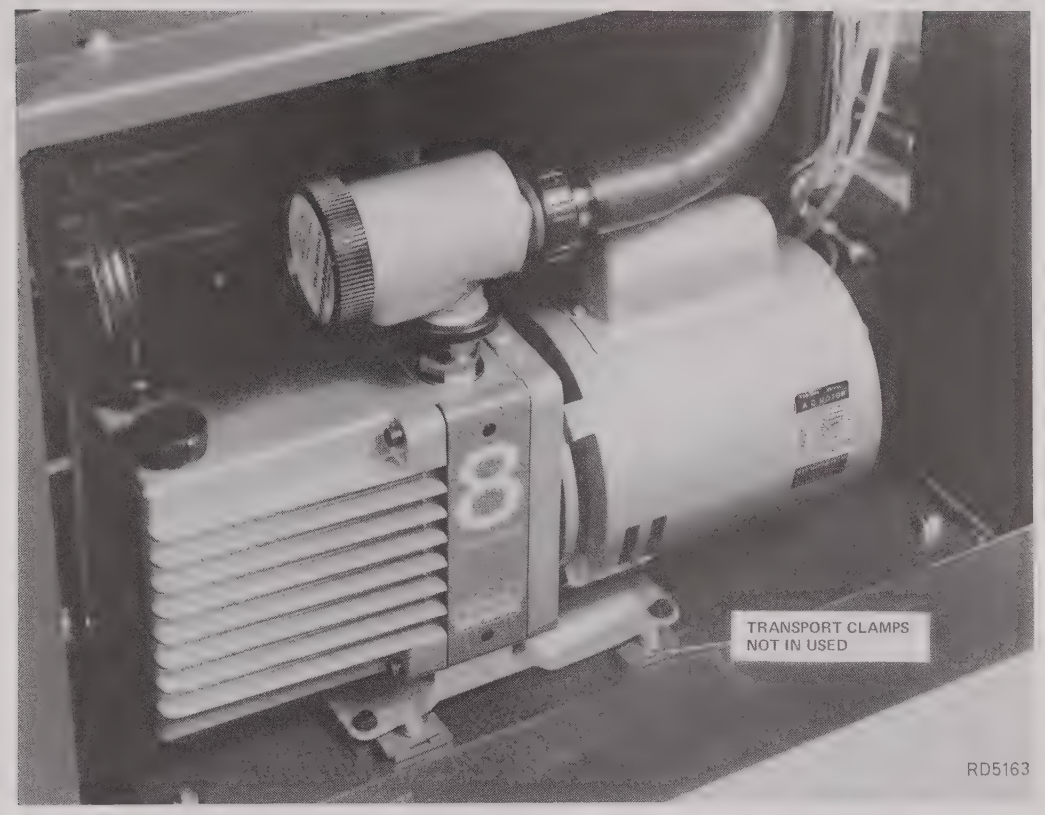


Fig. 3.4.2.1. Vacuum pump, type E2M8 – Ready for use

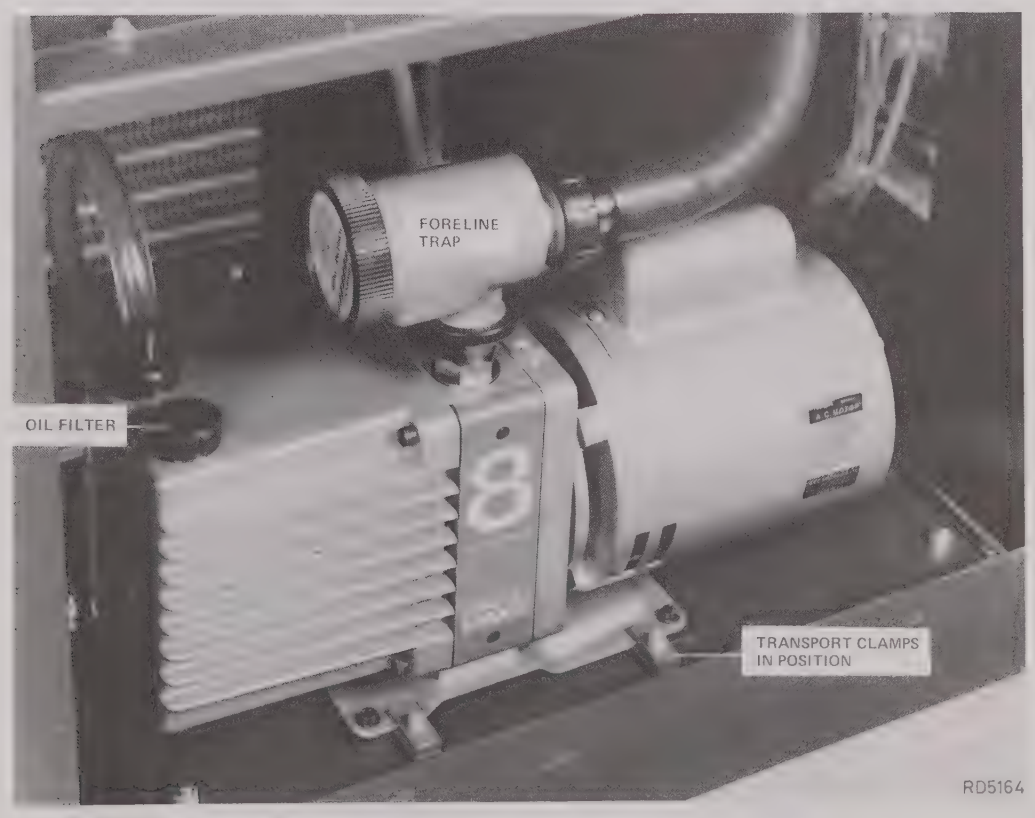


Fig. 3.4.2.2. Vacuum pump, type E2M8 – Ready for transport

3.5. GONIOMETER WORM HOUSE

Remove the plastic plug in the top plate of the goniometer worm house and fill the worm house with oil until the level is between one-half and two-thirds of the height of the round sight glass. Do not overfill. The oil is supplied separately packed in a polythene bottle. To avoid spilling the oil on other parts of the spectrometer place a metal rod or a screwdriver in the filling hole and allow the oil to run down it.

3.6. SAMPLE CHAMBER

3.6.1. Sample turret packing pieces

The sample turret is fitted with four loose carrier rings, and during transport these are prevented from moving by foam plastic packing pieces. Remove the plastic foam packing block holding the cap in position, open the cap unit by hand and remove the packing pieces from the loading position. Carefully rotate the sample turret, one position at a time, by turning the maltese cross disc on the drive shaft and remove the remaining three (see fig. 3.6.1.).

RD3459

Fig. 3.6.1. Removing the sample turret transport packing pieces

CAUTION

Do not attempt to rotate the sample turret by means of the lever on the motor shaft as this may damage the gearbox.

3.6.2. Collimator masks

The spectrometer is equipped with a mechanism enabling one of two collimator masks to be selected. When the spectrometer is delivered, a mask with a 24 mm viewing circle is normally fitted in position 2 (the right hand position when the mechanism is viewed from above). In position 1 no mask is fitted.

If it is required to fit either of the two alternative masks supplied proceed as follows:

(a) Remove the plate carying the cap mechanism (see fig. 3.6.2.).
In order to do this it will be necessary first to disconnect the electrical wiring, the vacuum hose, helium hoses (if fitted) and the compressed air hoses. These last are provided with bayonet-type quick release couplings which can be disconnected by pressing down, turning through about 90°, and pulling them free.

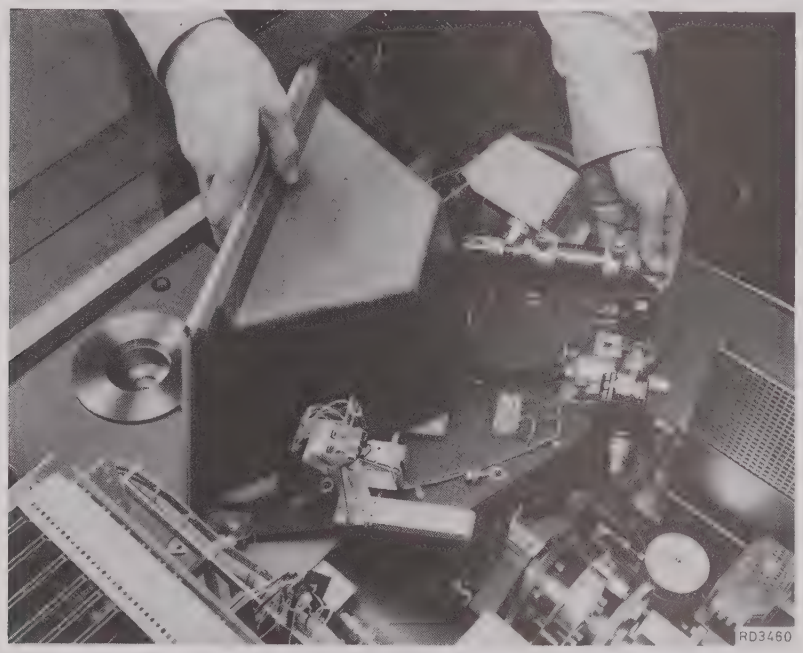


Fig. 3.6.2. Removing the cap mechanism

(b) Remove the lead/steel radiation shield covering the sample chamber

(c) Remove the sample chamber cover plate

(d) Remove the sample turret drive arm and compression spring, lift out the sample turret carefully and put it on a clean, dust-free, surface (see fig. 3.6.3.).

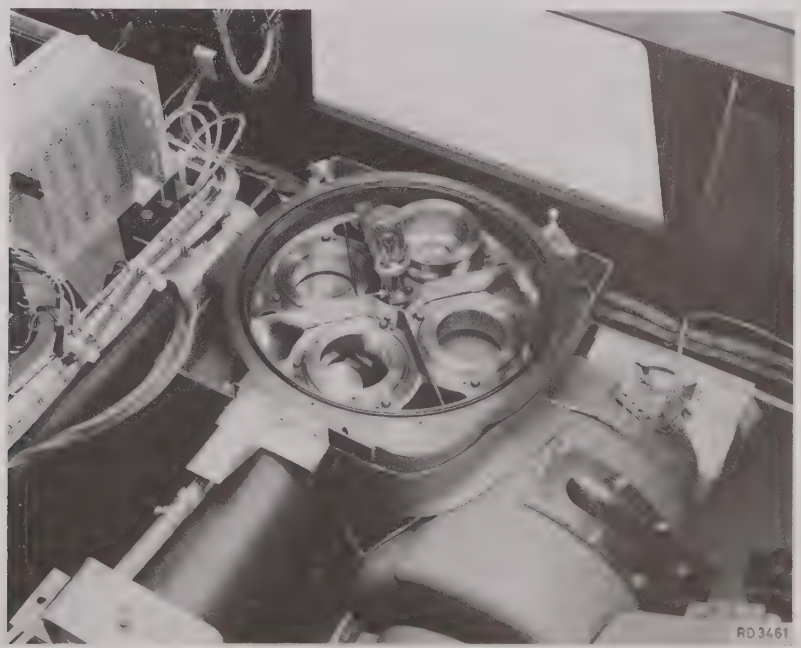


Fig. 3.6.3. Removing the sample turret

(e) Place the desired masks in position using the screws provided (see fig. 3.6.4.)

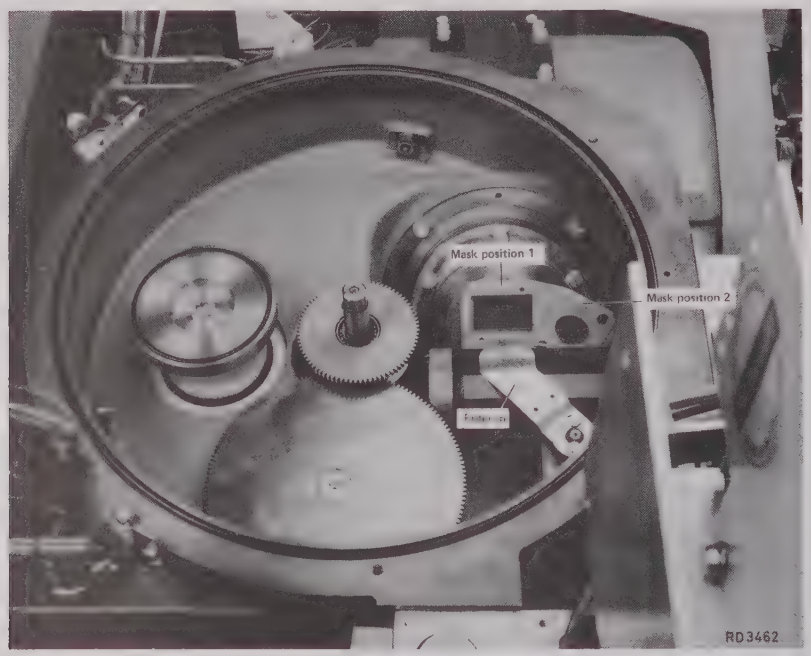


Fig. 3.6.4. Fitting collimator masks

(f) Replace the sample turret, refit the compression spring and the drive arm. Carefully align the turret and drive arm so that one of the loose sample carrier rings is placed centrally over the plunger before tightening the screw securing the drive arm.

(g) Replace the sample chamber cover plate, radiation shielding, cap mechanism, making sure that in each case the safety circuit microswitches are correctly operated.

NOTE

The hole in the cap mechanism mounting plate fits the boss round the loading position entry exactly. It will be necessary to manouvre it into position carefully, ensuring that the safety microswitch is correctly operated and not damaged during this process.

3.7. X-RAY TUBE

To insert the X-ray tube proceed as follows:

(a) Remove the sealing material over the X-ray tube entry point.

(b) Rest the X-ray tube in the tube cradle and attach the water hoses. Ensure that the hoses are connected so that the direction of water flow is correct. The direction of flow is indicated on the inlet and outlet pipes on the X-ray tube, and by arrows on the water hoses.

> **CAUTION**
>
> The direction of water flow through the X-ray tube is very important. Incorrect connection of the water hoses can result in irreparable damage to the X-ray tube.

(c) Coat the o-ring round the entry point very sparingly with Apiezon L vacuum grease and fit this carefully in the tube entry, behind the insulating ring. In early spectrometers, the insulating may be loose — in later models it is secured with an adhesive.

(d) Insert the X-ray tube carefully, lifting the connector end slightly to ensure that the filter mechanism is not damaged (see fig. 3.7.1.). The correct alignment of the X-ray tube has been determined in the factory, both horizontally and axially. Ensure that the outflow water hose connection passes in the inverted "U"-shaped guide, push the tube fully into place and check that the safety microswitch is operated. Rotate the X-ray tube as fully clockwise as possible.

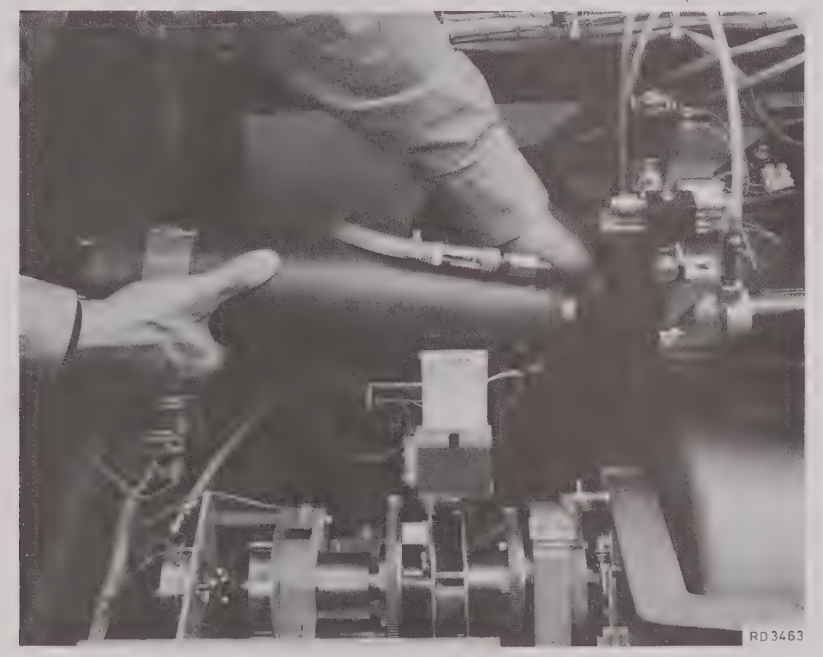


Fig. 3.7.1. Inserting the X-ray tube

If it should be necessary to adjust the horizontal alignment of the X-ray tube, place a straight-edge across the top of the sample chamber so that it is in contact with the locating pin and the edge of the hole in the upper surface of the sample chamber (see fig. 3.7.2.).
Adjust the X-ray tube with the two screws in the lower half of the tube cradle until it is parallel with the straight edge. Check also that after adjustment the X-ray tube is horizontal with a spirit level.

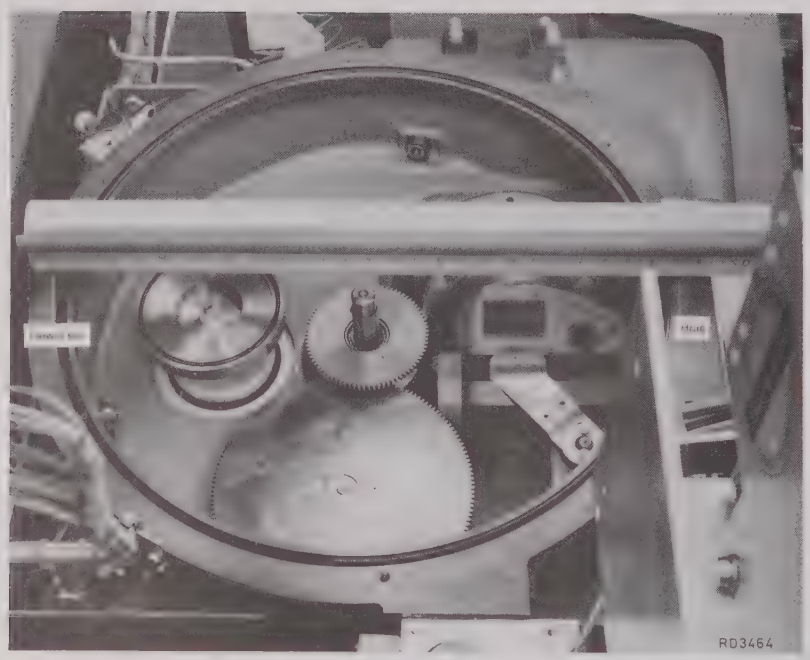


Fig. 3.7.2. Aligning the X-ray tube

(e) Coat the tapered rubber part of the HT cable connector with silicone grease (Wacker silicone) and insert the connector in the X-ray tube (see fig. 3.7.3.). Tighten the four securing screws fully.

> **CAUTION**
>
> Failure to adequately coat the connector with grease may result in its being almost impossible to remove it later.

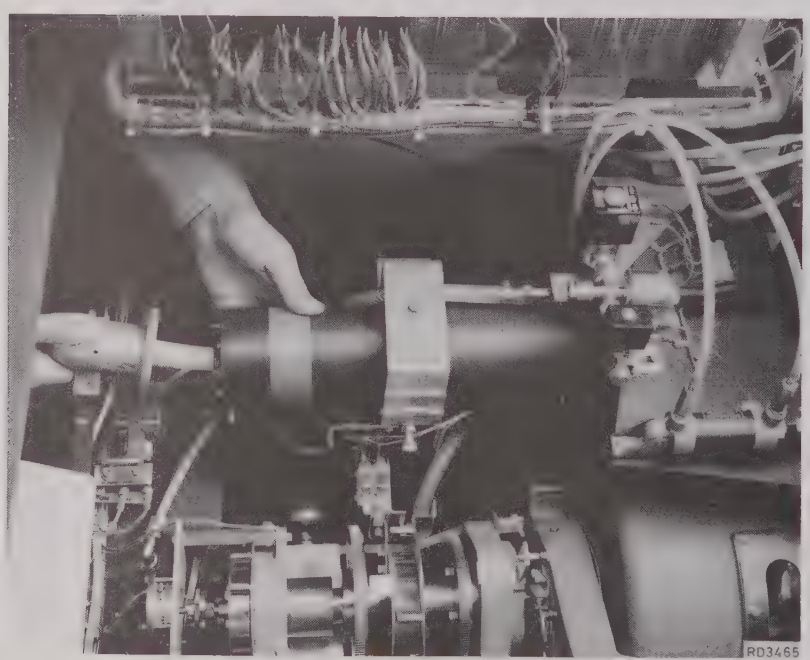


Fig. 3.7.3. Connecting the HT cable

(f) A flexible 11 metre earth wire is supplied with the spectrometer. Ensure that this wire is connected between the earth terminal on the X-ray tube and the earth terminal on the HT tank, and that it is secured by winding it round the HT cable.

CAUTION

Because the X-ray tube is insulated from the spectrometer it is essential that it be separately earthed to the HT tank in the X-ray generator.

(g) Ensure that the HT cable rests in the lower half of the cable clamp mounted on the rear frame of the spectrometer, with the earth wire in the groove (see fig. 3.7.4.)

(h) A safety plug is attached by a chain to the HT cable. Push this plug into the socket mounted on the X-ray tube cradle (see fig. 3.7.4.)

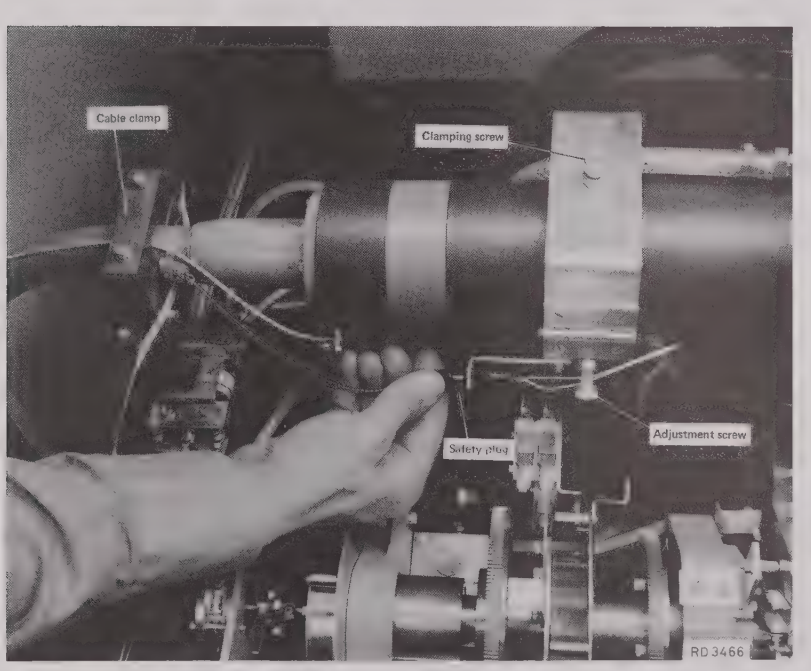


Fig. 3.7.4. Inserting the HT cable safety plug

3.8. X-RAYS ON LAMP

On spectrometers with serial number upto and including DY700, the "X-rays on" lamp is connected by a cable to the connector block X112 (see fig. 3.8.1.) and for transport purposes is attached to the X-ray tube support. Place the lamp in a prominent position where it can be seen by all persons in the vicinity.

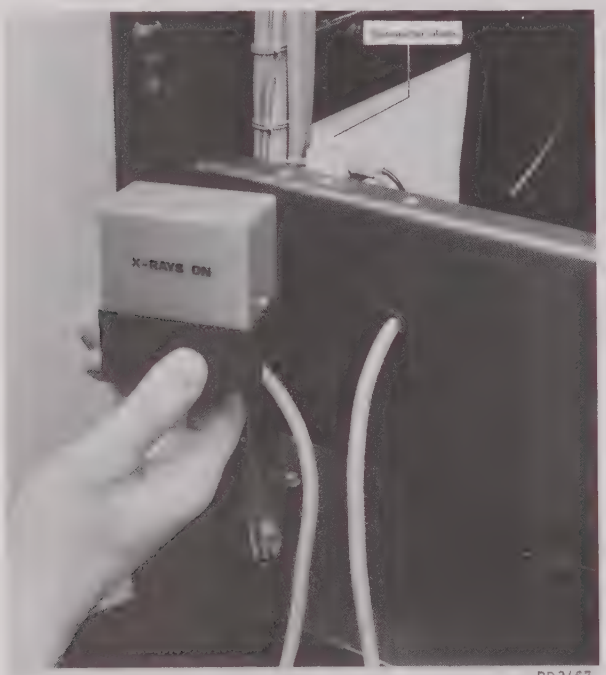
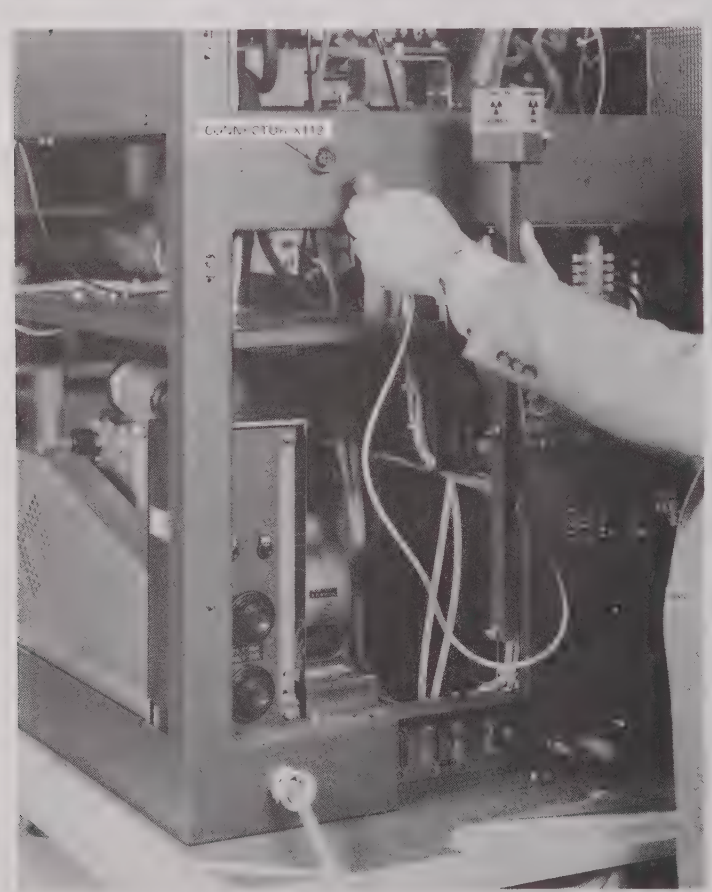


Fig. 3.8.1. Connection of X-RAYS on up to serialnumber DY700



On specyrometers with serial number stating with DY701, the "X-rays on" lamp is mounted on top of a post, and is connected to the safety circuit by means of the connector X112 (see fig. 3.8.2.).
Attach the post with the lamp to the upper rear panel of the spectrometer with the screws provided. The lamp will then be approximately at eye-level.

Fig. 3.8.2. Connection of "X-rays on" lamp for serial numbers starting with DY701

3.9. ELECTRICAL CONNECTIONS

(a) 220 V ac supply.
The 220 V ac supply cable is connected to the spectrometer via a cable clamp on the rear frame, and for transport is coiled up inside the unit. Connect the cable in the PW 1730/.. (see fig. 3.9.1.).

If a PW 1400/00 is ordered and delivered without an X-ray generator, a connection and fuse panel is delivered with the spectrometer. Mount the panel in the X-ray generator and connect is as shown in fig. 3.9.1.

CAUTION

1. To avoid earth loops, always connect the spectrometers as stated – never use separate supplies for the spectrometer and its X-ray generator.
2. Do not connect a computer to the power sockets on the back of the X-ray generator – this can lead to damaged diskettes if the generator is switched off.
   However, the computer must be connected to a supply having the same phase as the rest of the system.

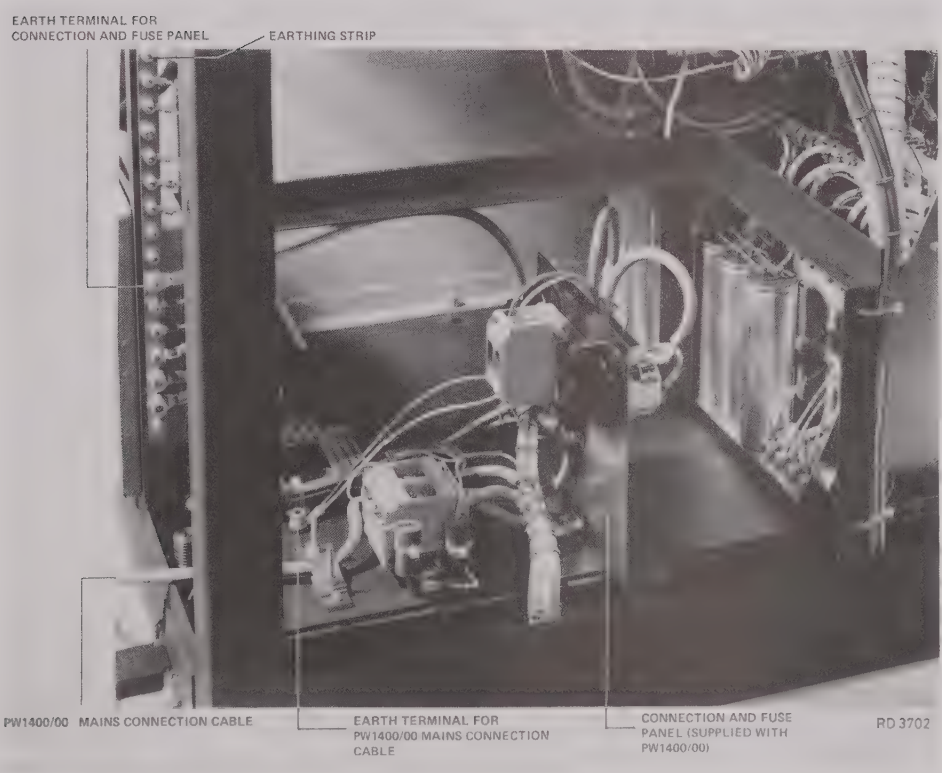

EARTH TERMINAL FOR CONNECTION AND FUSE PANEL
EARTHING STRIP
PW1400/00 MAINS CONNECTION CABLE
EARTH TERMINAL FOR PW1400/00 MAINS CONNECTION CABLE
CONNECTION AND FUSE PANEL (SUPPLIED WITH PW1400/00)
RD 3702

Fig. 3.9.1. Electrical connections in PW 1730/..

(b) Earth connection.
Connect the earth wire between the earthing strip on the spectrometer and the earthing terminal of the PW 1730/.. (see fig. 3.9.1.). The cross sectional area of the earth wire must not be less than 2.5 mm^2.
The earth connection must be free from radio frequency interference.

(c) Generator control connection.
Connect the control cable supplied between X103 on the spectrometer and X222 on the X-ray generator. (see fig. 3.9.2.).

(d) Computer and Peripherals.
Connect the cables from computer and peripherals to X104 and X105 as appropriate (see fig. 3.9.2.).

(e) Chart recorder.
Connect the chart recorder cable to X102 (see fig. 3.9.2.).

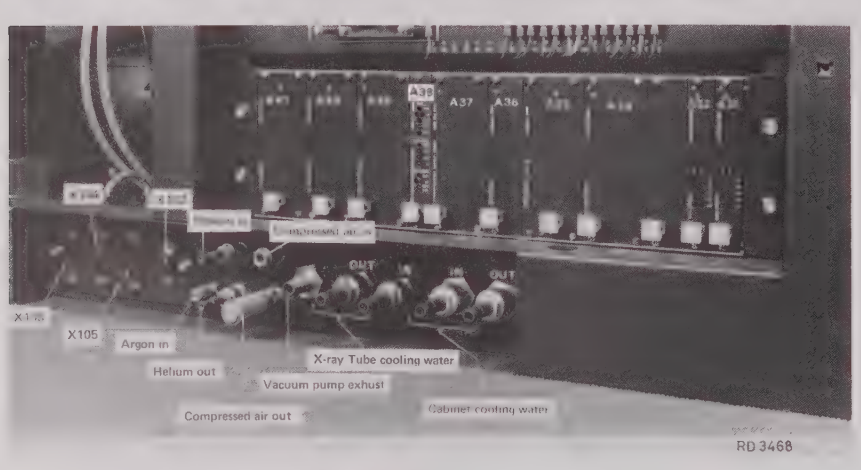


Fig. 3.9.2. Electrical and hose connection panel.

3.10. COMPRESSED AIR SUPPLY

Connect the compressed air supply to the point indicated in fig. 3.9.2. One of four connection methods can be used:

(1) Nylon hose, 8 mm i.d., fitted over the hose connector on the spectrometer and secured with a hose damp.

(2) Nylon hose, 8 mm o.d., with internal supporting tube, fitted to the pipe coupling in place of the exsisting hose connector (see fig. 3.10.1).

(3) Copper pipe coupling in place of the existing hose connector.

(4) Copper pipe or nylon hose with 1/4 in BSP connection.

Note that the compressed air supply line must have a reduction valve, a filter and a water trap to protect the PW 1400 from foreign matter (see chapter 1 for specification of compressed air). An oil mist lubricator is required for spectrometers with serial numbers up to and including DY750.

WARNING

1. Compressed air can be extremely dangerous if it is allowed to enter the human body.
2. Compressed air cylinders can be extremely dangerous if allowed to fall. Always ensure that cylinders are placed in a proper carriage or stand, or are secured to a wall.
   Always follow local safety regulations.

For spectrometers with serial numbers beginning with DY751, an oil mist lubricator is not required, since all actuators except for the plunger activator, are lubricated for life.

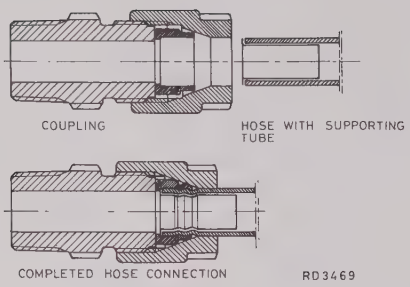


Fig. 3.10.1. Hose connection

3.11. WATER SUPPLIES

Two separate water circuits are provided in the PW1400/00, one for cooling the X-ray tube and the other for temperature stabilization. The water supply must be connected so that the flow of water through the system is as shown in fig. 3.11.1, except when a simultaneous spectrometry/diffraction arrangement is required.
Mount the water filter supplied with the X-ray generator in a convenient position on the wall close to the water supply tap.
Connect the water supplies with 12 mm copper pipe and 3/8 in BSP connectors or with 12 mm i.d. high pressure hose and hose clamps.

CAUTION

When a simultaneous arrangement is to be installed a different method of connecting the water supplies may be required. See service manual PW 173./..

If a diffractometer is to be used in a simultaneous arrangement with a PW1400/00 and a PW1730/.. two separate water supplies are required. In this case a series connection of the cooling circuit and the X-ray tubes is not possible and the water bypass valve is not required. The method of connection is shown in fig. 3.11.2.

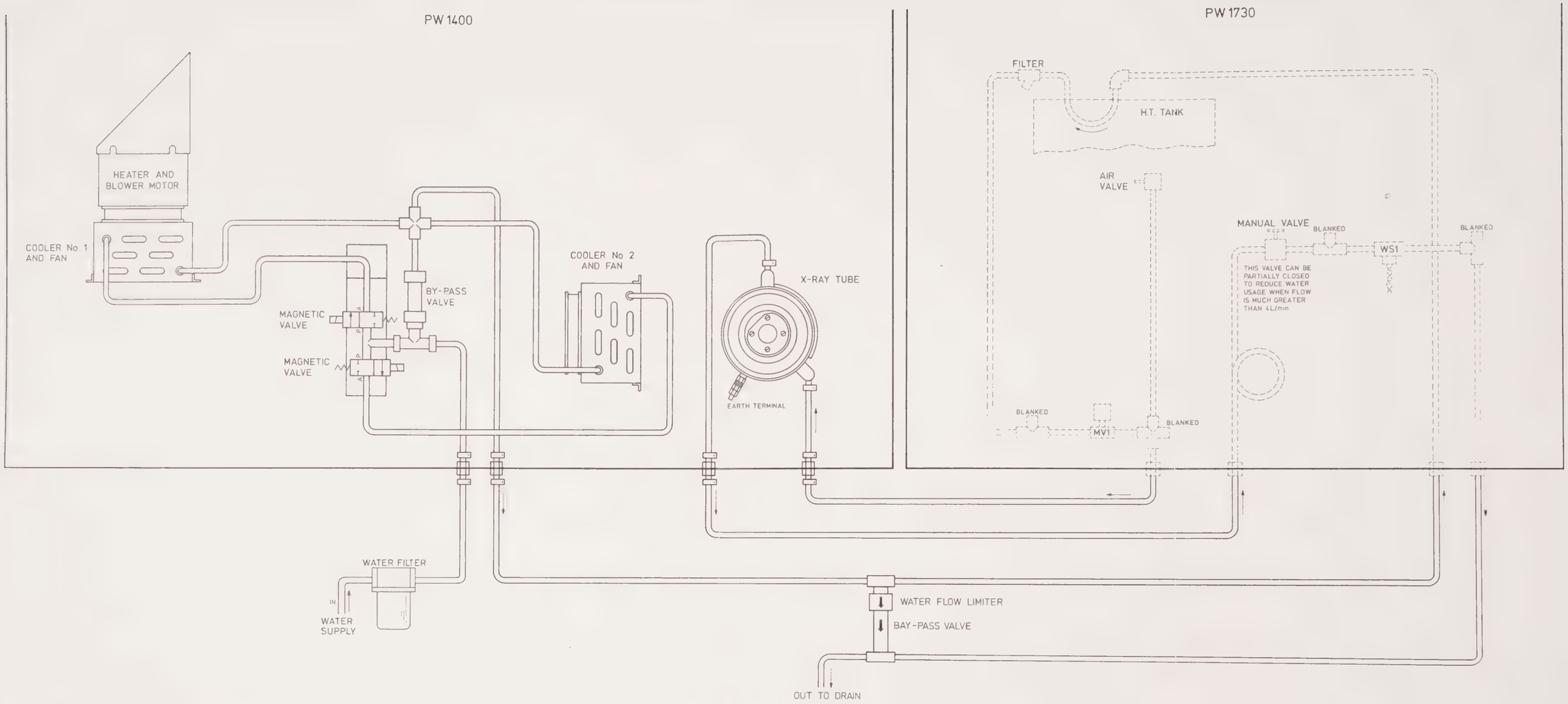


Fig. 3.11.1. Water supply connections

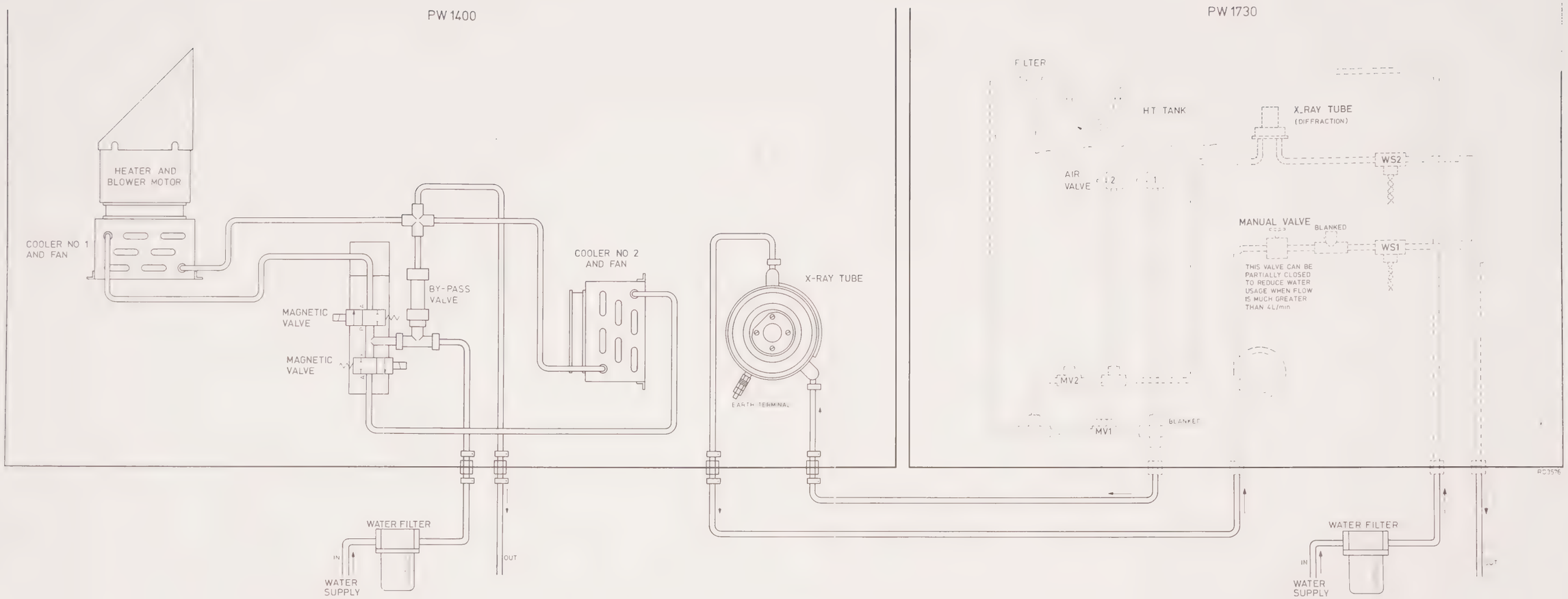


Fig. 3.11.2. Water supply connections for simultaneous operation

3.12. DETECTOR GAS

3.12.1. Connecting the gas cylinder

(a) Ensure that the cylinder of detector gas is securely mounted in a frame or stand or is properly secured to a wall.

> **WARNING**
>
> Gas cylinders can be extremely dangerous if allowed to fall. Always ensure that cylinders are properly secured and follow local safety regulations.

(b) Clean the connection on the gas cylinder to ensure that no foreign matter can enter the gas system in the spectrometer. Blow dust from the connection by rapidly opening and closing the valve by a small amount. Ensure that the connection is pointed in a safe direction

(c) Ensure that a new nylon sealing washer is present inside the coupling nut of the reduction valve.

(d) Fit the reduction valve assembly to the cylinder connection. Ensure that the feed pipe does not turn by gripping it with a suitable tool, and tighten the coupling nut securely.

> **NOTE**
>
> The coupling nut which attaches the reduction valve to the cylinder has a left-hand thread. Turn it clockwise to slacken it and counterclockwise to tighten it.

3.12.2. Putting the gas system into operation

(a) Ensure that the output adjuster of the reduction valve is fully open, i.e. the output adjuster is rotated fully counter clockwise.

(b) Open the main valve on the cylinder and check that the cylinder pressure gauge registers the expected value. For a new cylinder this is approximately 150 atm.

> **CAUTION**
>
> Always turn on the gas supply slowly. A large transient overpressure may damage the window of the flow detector.

(c) Rotate the output adjuster slowly and carefully in a clockwise direction until the output pressure gauge registers 0.7 atm.

(d) If desired the joints can now be checked for leaks with a soap solution. If this is done make sure that all soap is thoroughly washed off with clean water afterwards to ensure that no soap can enter the system when the joints are subsequently opened.

(e) Press the gas leakage reset pushbutton on the right-hand side of the spectrometer.

(f) Open the gas flow adjusting valve fully for several seconds to flush the system and then close it until the flowmeter indicates 1 litre/hour (see fig. 3.12.1.).

(g) When all the air is flushed out of the system check the quality of the detector gas. A difference in the gas composition can shift the value of the pulse height setting from its normal working value of 50% and this can be corrected by detector high voltage as described in 4.1.

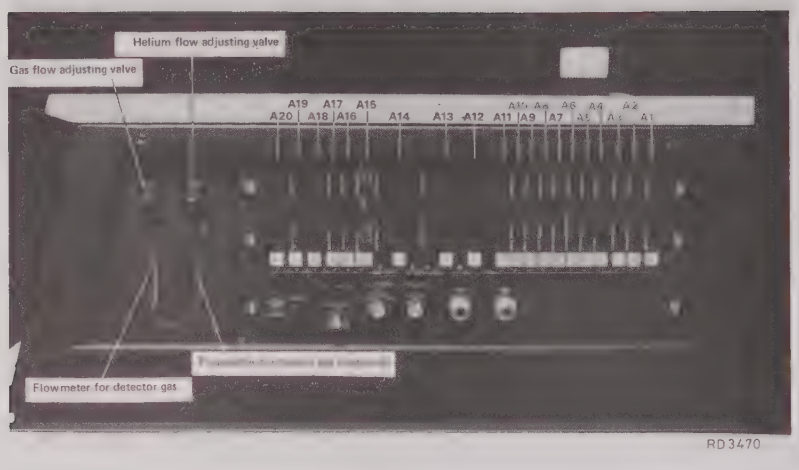

Helium flow adjusting valve
Gas flow adjusting valve
A19 A17 A15
A20 A18 A16 A14 A13 A12 A11 A9 A7
Flowmeter for detector gas
RD3470

Fig. 3.12.1. Service panel and electronics rack

3.12.3. High pressure gas leakage check

This procedure should be employed each time a cylinder of gas is connected to the spectrometer to ensure that there is no leakage of gas on the high pressure side of the reduction valve. It is better not to use a soap solution test because it would be possible for dried soap to enter and contaminate the system when the cylinder is subsequently changed.

If such a test is used all soap solution must be carefully washed off when the test is concluded.

(a) Close the reduction valve fully. In this condition the output adjuster will be turned fully counterclockwise.

(b) Open the main valve slowly. The cylinder pressure gauge will record a value of approximately 150 atm. Make a record of the pressure reading.

(c) Close the main valve of the cylinder fully and leave in this condition for approximately 30 minutes.

(d) At the end of this period compare the pressure reading with the pressure previously recorded. If the pressure is unchanged, there is no leak present. If the pressure has dropped this indicates a leak in the high pressure connection. Open the output aduster slowly to release any residual pressure and then fully close it again. Disconnect the cylinder, clean the coupling carefully with petroleum ether, fit a new nylon washer, reconnect the cylinder and repeat the high pressure gas leakage check.

3.12.4. Check for correct operation of gas density stabilizer

The following procedure may be used to check the correct operation of the gas density stabilizer;

(a) Close the output adjuster until the output pressure gauge indicates approximately 0.3 atm.

(b) Adjust the gas flow until the flowmeter indicates 1 litre/hour.

(c) Open the output pressure adjuster slowly until the output pressure gauge indicates approximately 1.2 atm.

(d) Check that the indicated flow rate has not changed by more than a small amount. This pressure increase by a factor of four should cause very little increase in the flowrate unless the gas density stabilizer requires cleaning. This can only be done by an experienced service engineer. **(see chapter 5.6.5.).**

(e) Slowly reduce the output pressure to 0.7 atm.

> **NOTE**
>
> This test checks for the operation of the gas density stabilizer within limited input pressure limits. It does not check that the correct absolute gas density is achieved.

3.12.5. Positioning of gas cylinder

It is advisable to place the gas cylinder as close as possible to the spectrometer
This will ensure that short gas lines are used and that the gas entering the spectrometer will be at room temperature.
If the gas cylinder must be placed elsewhere, and especially if it must be placed outside the building, ensure that it not exposed to the sun or to frost. Ensure also that the gas lines are made from specially cleaned oxygen-free copper pipe with as short a length as possible.

> **CAUTION**
>
> Any contamination of the detector gas is likely to result in poor detector resolution.

3.13 CONNECTION OF COMPUTER AND PERIPHERALS

3.13.1. Interfaces

The spectrometer is supplied with one serial interface pcb in position A20 (see fig. 3.12.1.). This is interface No. 1. and must be used for a computer and/or for a peripheral unit which is to be used for input commands. Connection to this interface is made via connector X104 (see fig. 3.9.2.)
A second interface (PW1715/00) can be placed in position A19. This interface can only be used to supply an output device such as a hard-copy printer. Connection to this interface is made via connector X105 (see fig 3.9.2.).

3.13.2. Jumper and switch settings on interface pcb's.

Set jumpers and switch positions for the desired peripherals as indicated in chapter 4.

> **NOTE**
>
> Jumpers and switch positions may also need to be set in the peripherals themselves. Information on this for some common peripherals is given in chapter 4.

3.14. CRYSTAL CHANGER

The spectrometer is delivered with the goniometer set to 0^{o} 2θ.
Unpack the crystal changer and remove the red-painted transport clamp. Store this clamp in a safe place if the crystal changer ever needs to be transported, this clamp must be re-fitted.
Insert the crystals in the crystal changer taking care not to touch their surfaces. Make a note of the positions in which the crystals are fitted. Adjust all the crystals so that they are positioned centrally in the holders and appear to be parallel with the central shaft of the crystal changer:

CAUTION

Do not touch the surface of the analysing crystals-always hold them by their edges. Deposits left by the fingers can result in inaccurate measurements when the spectrometer is in use and may prove impossible to remove.

Detach the laminated spacing washer (tied onto the frame) and place it over the 1θ shaft inside the crystal chamber.
Place the crystal changer on the 1θ shaft and align it by eye so that the upper surface of one of the crystals is in line with the primary collimator and the gas-flow detector collimator and tighten the clamping screw.
Rotate the crystal changer carefully by hand to ensure that the longer crystals do not touch any part of the crystal changer or the gas-flow detector.

3.15. SPECTROMETER ALIGNMENT

(a) Fit the transparent cover to the crystal chamber. Hold it in place by hand and ensure that the safety circuit microswitch S41 is activated with the special tool provided (see fig. 3.15.1.).

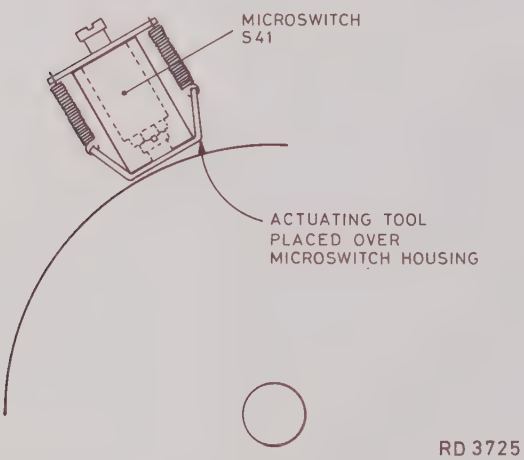


Fig. 3.15.1. Safety microswitch actuating tool.

(b) Assemble a channel for copper (ACH Cu, see operation manual).

(c) Select the following conditions:

Filter	: out
Crystal	: LIF 200
Order	: 1st
Detector	: Flow
Spinner	: off
Vacuum	: off
Collimator	: Fine
Time Constant	: 1 second
Lower level	: 15%
Upper level	: 80%
Sample	: Copper
KV	: 30
mA	: 10

(d) When the generator was switched on the stepping motor should have calibrated. Depress push-button ANGLE - the display should read 000.000.

(e) Set the goniometer to 44,000° 2θ, insert the special screw driver in the transparant cover and adjust the LIF 200 crystal to give a maximum deflection on the chart recorder (see fig. 3.15.2.). Note the angle on the chart recorder paper.

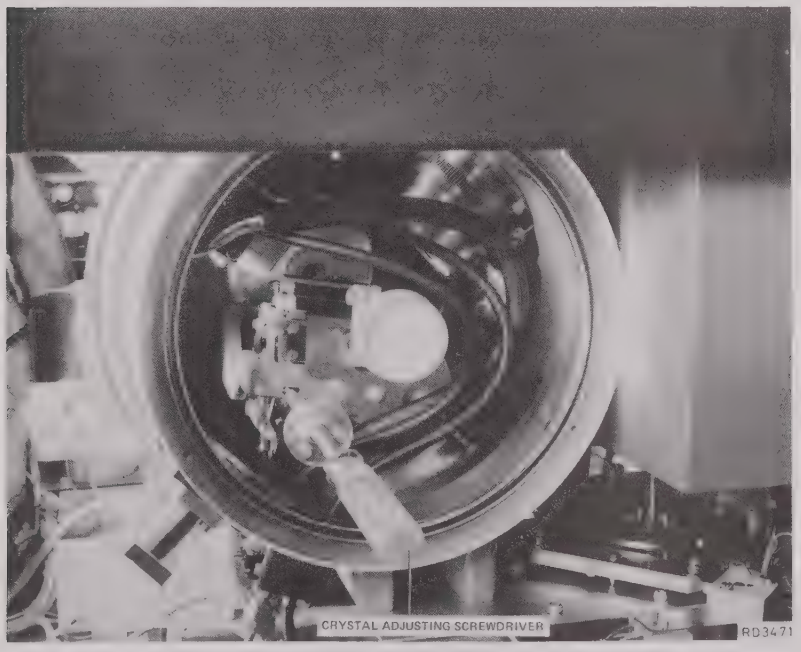


Fig. 3.15.2. Crystal adjustment

(f) Advance the goniometer insteps of 0,1° 2θ, (use command SSM) and after each step adjust the crystal holder for maximum deflection. Note the angular settings against each recording on the chart. Continue until the maximum indication is decreasing.

(g) Draw a cured line through the points of maximum indication for each step on the chart and calculate the angle at which the highest reading occured.

(h) Set the goniometer to the angle where the highest reading occurred and adjust the crystal for maximum deflection.
This angle is 45,030° 2θ. If this angle does not appear in the display, calculate the difference between this angle and the displayed angle and proceed as follows:

(j) Turn the stepping motor in steps until the holes in the coupling are in line with the holes in the housing and the clamping screws in the coupling are uppermost, insert the locking bar and tighten the nuts (see fig. 3.15.3.).

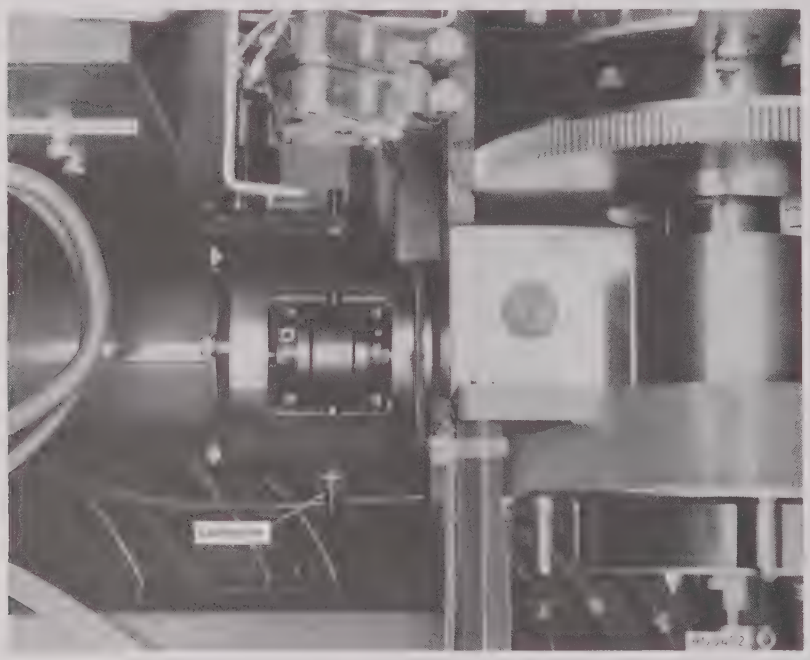


Fig. 3.15.3. Locking the stepping motor coupling

(k) Note the angular reading on the display and add to it the difference (plus or minus) found in step (h).

(l) Slacken the coupling at the motor shaft side and set the motor to the angle calculated in step (k). Retighten the coupling and remove the locking bar.

(m) Set the goniometer to 45,030° 2θ and check that the maximum deflection of the chart recorders occurs at this angle.

(n) Adjust the other crystals by setting the goniometer to a suitable element line and turning the crystal adjusting screw to obtain maximum deflection of the chart recorder. If alignments must be made using elements lighter than Ca it is necessary to have the spectrometer evacated.

CAUTION

1. Do not withdraw the crystal adjusting screwdriver while the system is under vacuum. This can cause damage to the gas-flow detector window.
2. Do not allow the crystal adjusting screwdriver to obstruct the crystal changer or hoses when the goniometer is moving.
3. Do not press the RESET pushbutton while the crystal adjusting screwdriver is in position. This will cause the goniometer to run to 000,000° and damage the crystal changer.

For the alignment of the other crystals, the following conditions provide the best results:

		SAMPLE	ELEMENT	VACUUM	2θ ANGLE
LiF 220		Cu	Cu	NO	65.56
LiF 200		Cu	Cu	NO	45.03
Ge		NaCl*1	Cl	YES	92.76
	or	S*2	S	YES	110.69
Graphite		NaCl*1	Cl	YES	89.53
	or	S*2	S	YES	106.29
InSb		Si*3	Si	YES	144.76
PET		Al	Al	YES	145.13
ADP		Mg*4	Mg	YES	136.67
TIAP		Al	Al	YES	37.80
	or	NaCl	Na	YES	55.10

*1 Press NaCl (= table salt) into a solid pellet (e.g. 30 seconds at 20 tons).

*2 Sample with high sulphur content but essentially free of molybdenum.

*3 High silicon sample e.g. PW1302/00 or geological sample (e.g. granite) or ferrosilicon.

*4 High magnesium sample e.g. solid pellet MgO or high Magnesium alloy.

For each of these alignments the appropriate channel must first be assembled.

(o) Align to primary collimator as described in Chapter 5.12.5. and 5.12.6.

(p) Align the mask mechanism as described in Chapter 5.20.7. and 5.20.8.

(q) Align the aluminium filter as described in Chapter 5.21.5. and 5.21.6.

(r) Align the scintillation detector and auxilliary collimator for maximum intensity using CuKα and an angle of $45.030^{o}2^{o}$ as found for the gas flow detector.

3.16. 60 Hz OPERATION

The PW1400/00 is normally delivered in a 50 Hz version except when ordered as a 60 Hz project.
For 60 Hz operation the following changes must be made during installation.

(a) Spinner drive mechanism (fig. 3.16.1.).
Remove the spinner drive mechanism and replace the gearbox with the separately packed gearbox.
The gearboxes can be identified by their overall gear ratios (including the motor pinion) as follows:

50 Hz : 1:16,66

60 Hz : 1:20

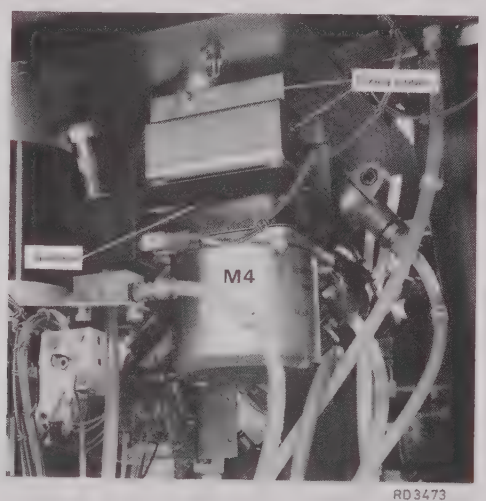


Fig. 3.16.1. Spinner motor and gearbox

(b) Vacuum pump
Change the position of the driving belt on the pulleys of the vacuum pump and the pump motor.

(c) Jumper settings
On the motor drive pcb A 36 open the jumpers W1, W2, and W3. (For 50 Hz operation these jumpers must be closed) (see also fig. 4.6.2.).

(d) On the sample changed motor drive pcb A2, open the jumpers W1, W2, and W3. (For 50 Hz operation these jumpers must be closed (see also fig. 4.11.3.5. and 4.11.3.6.).

(e) On the motor drive pcb A2, remove the capacitors C1B and C2B and substitue capacitors of 12,5 μF (see also fig. 4.11.3.5. and 4.11.3.6.).

3.17. HELIUM SYSTEM PW 1464/50

The helium system is an option supplied as a pre-assembled kit. All the wiring required to operate the system is already present in the spectrometer. The system should be installed as follows:

(a) Main helium valve

Disconnect the vacuum hose from the lower side of the main vacuum valve and mount the main helium valve on the main vacuum valve by means of the coupling provided (see fig. 3.17.1.)

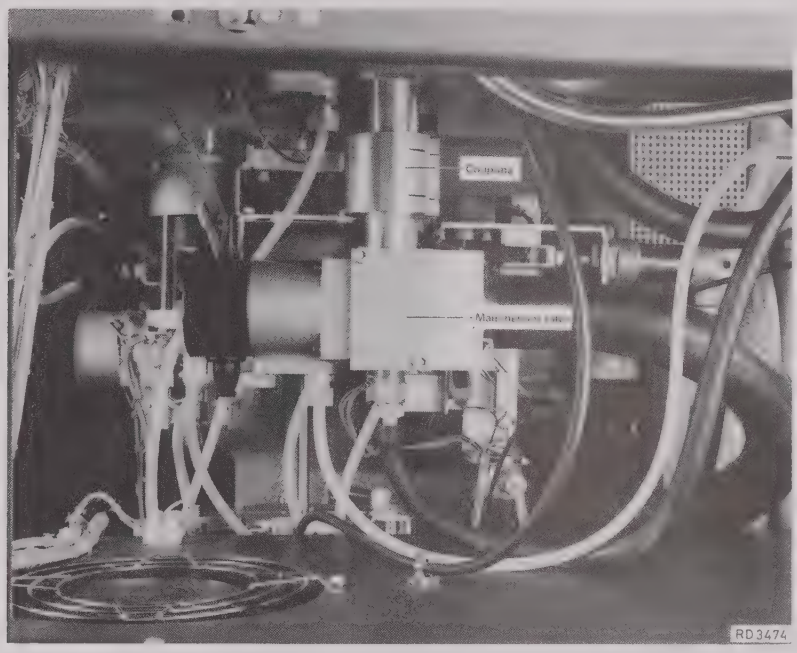


Fig. 3.17.1. Main helium valve

Reconnect the vacuum hose to the lower side of the main helium valve.

(b) Cap unit.

Spectrometers having serial numbers upto and including DY950 have a cap unit which is suitable only vacuum.

Remove the existing cap unit and substitute the special helium cap unit with helium connection.

The cap unit is attached to the cap unit mechanism by means of two screws. For safety reasons these screws cannot be removed in normal circumstances. To gain access to to the screws first remove the plate on which the cap unit mechanism is mounted (see fig. 3.6.2.), and then remove the polyurethane housing from the plate.

When the cap unit mechanism plate is remounted ensure that the safety microswitch S39 is actuated.

Spectrometers having serial numbers starting with DY951 have a universal cap unit which is suitable for both vacuum and helium; substitution of another cap unit is not necessary. Therefore, Helium Systems with serial numbers starting with DY691 do not include a special cap unit.

(c) Helium valve unit.
Mount the helium valve unit on the frame at the righthand side of the spectrometer frame (see fig. 3.17.2. and 3.17.3.). The electrical wiring for the helium system is present in the spectrometer, the connector for the helium valve unit being attached to the spectrometer frame close to the mounting position.

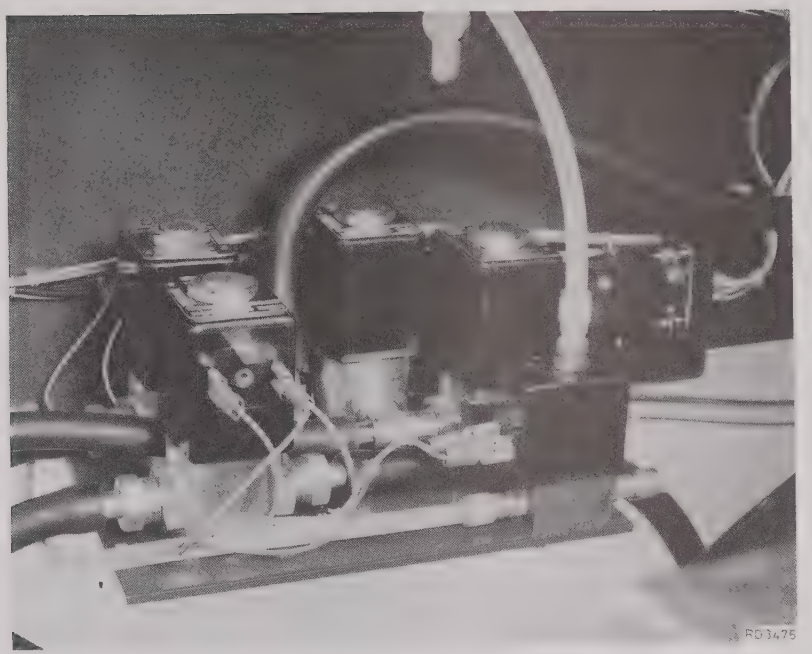


Fig. 3.17.2. Helium valve unit

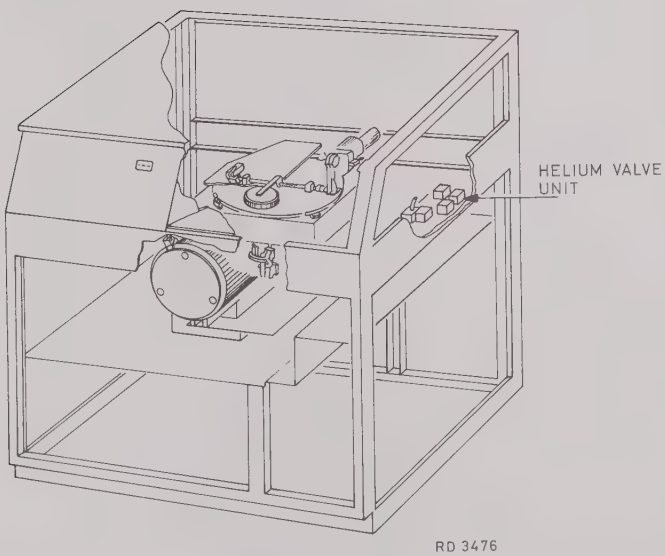


Fig. 3.17.3. Position of helium valve unit

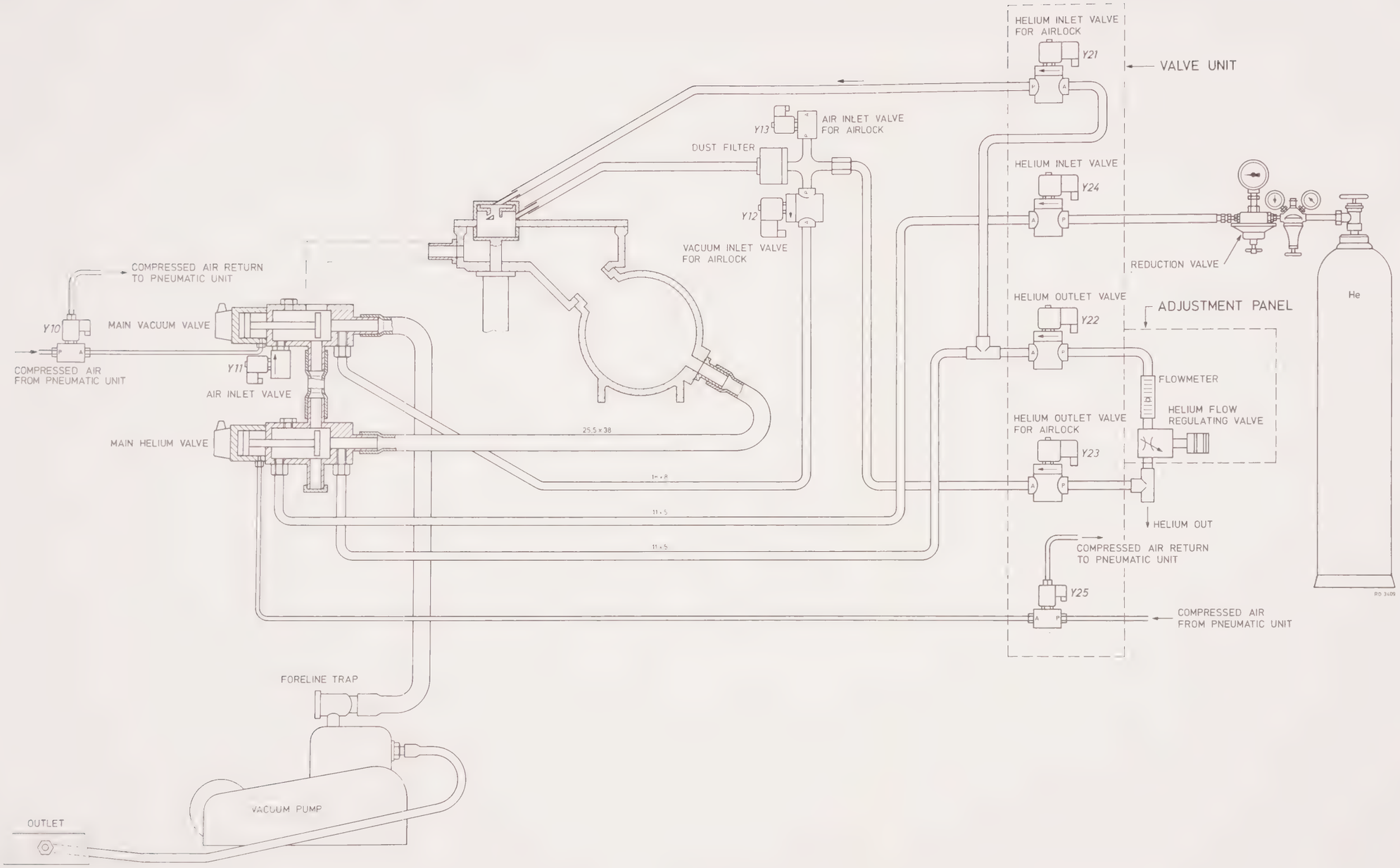


Fig. 3.17.4. Helium and compressed air hose connections

(d) Control panel
Remove the blank panel from the main control panel at the right-hand side of the spectrometer and mount the control panel using the screws removed with the blank panel (see fig. 3.12.1.).

(e) Hose connections
Complete all the helium and compressed air hose connections as shown in fig. 3.17.4.
For spectrometers having serial numbers up to and including DY950, connect the hose to the cap unit and secure it under the clamp at the side of the cap arm.
Pass the hose through the hole in the right-hand wall of the polyurethane cap unit housing, and ensure that the cap unit moves freely without straining or chafing the hose (see fig. 3.1.7.5.).

Fig. 3.17.5. Helium system cap unit (for spectrometers up to and including DY950)

(f) Connection of gas cylinder.
Fit the reduction valves to the gas cylinder using if necessary one of the extra sealing washers supplied. When tightening the nut,hold the pipe between the valves and the cylinder with a suitable tool to ensure that when the nut is tightened the pipe does not turn.

> **WARNING**
>
> Gas cylinders can be dangerous if not handled with care. Ensure that the cylinder is firmly secured to a wall or placed in a properly designed stand. Always comply with local safety regulations.

(g) Gas pressure and flow rate.
Ensure that the primary and secondary pressure adjusters are completely closed. Open the valve on the gas cylinder and check that adequate pressure is present.
Open the primary pressure adjuster until the pressure gauge reads 1.5 atmosphere.
Open the secondary pressure adjuster slowly until the pressure gauge reads 0.06 atm.
Ensure that the system is fully evacuated (VAC push button depressed).
Depress the HELIUM pushbutton and wait until the system is full with helium. Initially (for about the first ten seconds) the gas flow rate is high and this will cause audible vibration of the membrane in the reduction valve.

After a fixed time of approximately one minute the helium outlet valve will open automatically. Adjust the helium flowrate to 60 litres/hour.
Depress the VACUUM pushbutton and evacuate the spectrometer. When the internal pressure has been reduced to a normal working level, depress the HELIUM pushbutton for a second time. After about two minutes the spectrometer will have stabilized and will be ready for use.

NOTE
This double evacuation and filling procedure is necessary in order to remove air trapped in the hoses between the gas cylinder and the helium valves.

3.18. TEMPERATURE STABILIZATION

The temperature in the spectrometer cabinet is set by means of the TEMPERATURE control and the operation of the temperature stabilization system can be seen by observing the LED's C1, C2, and %, which light when cooler 1, cooler 2, and the heater respectively are operating.
Set the TEMPERATURE control to the middle of its range, close all the panels on the spectrometer, and allow the temperature to stabilize (at least 6 hours).

When the temperature is stabilized observe the LED's C1, C2, and %. If C1 lights continuously this indicates that the set point is set too low. Adjust the TEMPERATURE control slightly clockwise.

If the % LED lights continuously this indicates that the set point is set too high. Adjust the control slightly counterclockwise. Continue with this process until a heating and cooling cycle is established in which the % lamp flashes continuously and the C1 LED lights about 12 times per hour.

The C2 lamp lights when cooler 2 is active. This only occurs when the ambient temperature is very high.
The % LED flashes with a frequency of 1 Hz as an indication that the temperature is within the linear control range (i.e. within ± 0,05 ^{o}C of the set point).

3.19. SPECTROMETER STABILIZATION

When the spectrometer is first connected to the mains a period of at least 12 hours must be allowed before it is fully stabilized and consistent measurements can be made. Do not switch off the mains or water supplies at night or at weekends. It is also preferable to maintain power on the X-ray tube at all times since this tends to lengthen the life of the tube and to improve stability. When the spectrometer is not in use for long periods, such as over night or during weekends, settings of 50 kV and the lowest possible mA are preferable. For short periods between measurements, settings in the region of the normal measuring conditions should be chosen. This situation can be achieved in practice by choosing suitable settings on the manual controls of the X-ray generator.

3.20. INSTALLATION CHECK LIST

During installation, and before the PW1400 system is switched on, the following must be checked:

1. Determine the crystals required for sample measurement, and define the mounting positions in the sample changer. Set the jumpers for crystal attenuation on spectrometers Control 1 pcb.
   Keep a record of the crystal types and changer mouting position.
   Align the crystals after switch on.
2. Determine the size of the two collimator masks to be used, and define the positions, 1 or 2.
   Keep a record of the size, and position fitted.
3. Are the following supplies correct?:
   - Electrical mains supply (voltage taps and 50/60 Hz connections).
   - Water to the generator and spectrometer.
   - Compressed air.
   - P10 gas.
   - Helium gas (if PW1464 is installed).

   After switch on adjust the supplies as necessary.
4. Are the peripheral devices connected? Such as printer, VDU, computer, etc.
   Check that jumpers on the interface circuits, etc., are correct, and the device switches are properly operated.
5. Is the X-RAYS ON warning lamp connected, and all safety switches closed? Such as X-ray tube safety plug, cover switches, etc. After switch on, the mains water flow to the generator must be more than 4 litres per minute.
6. Set the H.T. generator kV and mA selector controls to the minimum position. Also operate the rear key-switch (if fitted).

The PW 1400 system can be switched on by operating the generator MAINS I push-button (after switching on the electrical mains and water supply).

After switch on check the following:
- Temperature control setting (after a stabilisation period).
- Battery switched on, located on the bus interface board.
- Detector H.T. setting.
- Adjust the water flow (if required), see generator Service Manual.
- Adjust gas flow (P10 and helium).
- Check the operation of the vacuum system.
- Is the initiation program of the microprocessor software correct?., i.e. there are no PROM or RAM errors.
- Before use, input the PWR command, see paragraphs 1.2. and 1.6.3. in operation manual. Also check the setting of X-ray tube power and current (mA) on the PW 1745 overload protection unit, if installed in the generator.
- Check the contents of the parameter bank (PPB command), and clear the data (CPB command) if required.

The H.T. can now be switched on by operating the HIGH VOLTAGE I push-button. If necessary the I and O push-buttons should be depressed simultaneously for a short period to clear any air bubbles from the water system.

Manually increase the generator kV and mA controls, in accordance with the procedure described in paragraph 6.4. in the Operation Manual.

3.21. PW1500/05/06 SAMPLE LOADER AND PW1500/10/15/16 SAMPLE CHANGER

The sample holder or sample changer will always be packed separately from the spectrometer to which it must be fitted. The units are supplied with the necessary connection cables, the sample changer control pcb and the sample changer ROM pcb to be fitted in the spectrometer. The spectrometer wiring includes the connexions and connectors for the addition of either the sample loader or sample changer. In addition, a sample loader has the material required for connection to the spectrometer pneumatic system.

Note that sample trays (PW1505/00 set of 5) and sample holders must be ordered separately.
Also note that the PW1400/00 microprocessor software must be at least version 2.0.

3.21.1. Unpacking the unit

The following items are supplied for installation in the spectrometer (PW1500/00/05/06 and PW1500/10/15/16):

QTY	Description	Service code
1	Sample changer ROM pcb (A18) PW1502/00	5322 694 14512
1	Sample changer control pcb (A11)	5322 694 14378
2	Lamp Osram 2403	5322 134 44081
1	Light emitter, Cometa EL14	5322 130 34285
1	Light receiver, Cometa RP14	5322 130 34286
2	Mounting plates	–
4 sets	M3 screws, spring washer, and flat washer	–

Items supplied with the PW1500/00 sample loader are:

- Sample changer ROM pcb A18
- Sample changer control pcb A11 } Fitted in the spectrometer
- Light emitter/receiver and mountings }
- 6 mm Allen key 4822 395 50019
- 8 mm Allen key 4822 395 50092

Items supplied with the PW1505/00 Reference tray option are:

- Pneumatic coupling and hose
- Dust cover

Items supplied with the PW1500/10 Sample changer are:

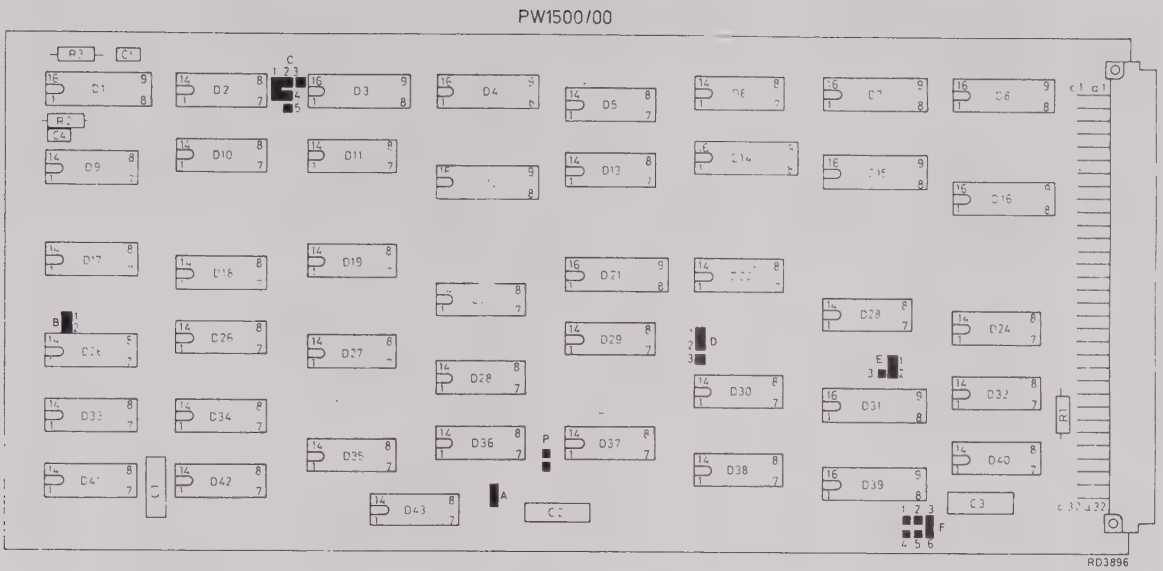
- as for PW1500/00.

3.21.2. Fitting the PW1500/00/05/06 Sample Loader

Before installing the sample loader switch off the mains power to the spectrometer. The detection system at the spectrometer loading hole, and the pneumatic supply (required for the PW1505/00,) can then be fitted to the spectrometer as follows:

PW1400/00 spectrometer

- Take off the table top.
- Mount the light emitter (lamp) and receiver, one on each side of the loading housing, using the brackets supplied, and as shown in figure 3.21.2.2.
- Connect the wiring from the emitter to terminals 3 and 4 of connector X68A, see figure 3.21.2.2.
- Switch on the PW1400/PW1730 and the emitter lamp should light.
- With a sample holder in the loading hole, adjust the height of the emitters so that the beam to the receiver is blocked.
- Remove the sample holder and check that the beam shines onto the receiver.
- Measure the resistance across the light receiver, and adjust its height so that the resistance is less than 1,5 kΩ.
  It should then produce a potential of less than 1 V.
- Turn the emitter from side to side to ensure that the lamp is correctly aligned.



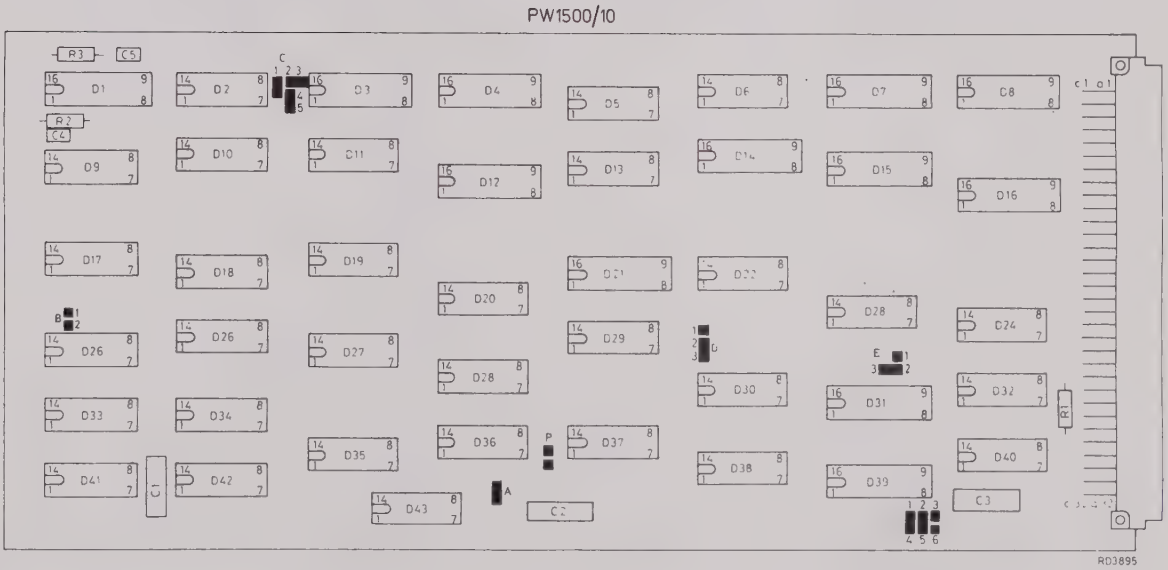


Fig. 3.21.2.1. Sample changer control pcb A11 - jumper points

– Replace the sample holder in the loading hole and check that it still blocks the beam, and that when it is removed the minimum receiver resistance is unchanged. Tighten the detector fixing screws.

– Connect the receiver wires to connector X68A, white to terminal 1, and blue to 2.

When a PW1505/00 is to be fitted, a compressed air connection is necessary. A quick-release connector must be fitted at the bottom right side of the front of the spectrometer, see figure 3.21.2.3. Proceed as follows:

– Remove the electronics rack at the lower rear of the PW1400/00.

– Remove the sealing plug in the tee-piece which is immediately behind the compressed air inlet, see figure 8.2.19.

– Fit the 8 mm nipple and coupling, mounted on the air hose, to the tee-piece.

– Remove the quick-release connector from the air hose, and take off the fixing nut.

– Insert the connector, from the front, in the position shown in figure 3.21.2.3., at the right side of connector X110.

– Refit the air hose to the quick-release connector.

– Check the adjustment of the restrictions (see PW1505/00, PW1506/00 installation-procedure).

The sample changer control pcb can now be fitted in position A11 of the rack at the right-hand side of the spectrometer (see fig. 3.21.2.4.) but first check that the jumper connections are correct i.e. selection for PW1500/05/06 or 10/15/16 as shown in the table 3.21.2.1. below:
Fit the sample changer ROM pcb in position A18 of the rack at the right-hand side of the spectrometer (see fig. 3.21.2.4.).

Table 3.21.2.1. – jumper settings on changer control pcb A11

Jumper Settings PW1500/15/16		Jumper Settings PW1500/00/05/06
A	closed	closed
B1-B2	opened	closed
C1-C2	opened	closed
C1-C4	opened	closed
C2-C3	closed	opened
C4-C5	closed	opened
D1-D2	opened	closed
D2-D3	closed	opened
E1-E2	opened	closed
E2-E3	closed	opened
F1-F6	closed	closed
F4-F6	closed	opened
F3-F6	opened	closed
F2-F3	closed	closed
F3-F5	closed	opened
P	opened	opened
Time 1 Time 2 τ 1 τ 2	Time settings are factory adjusted and should not be reset.	

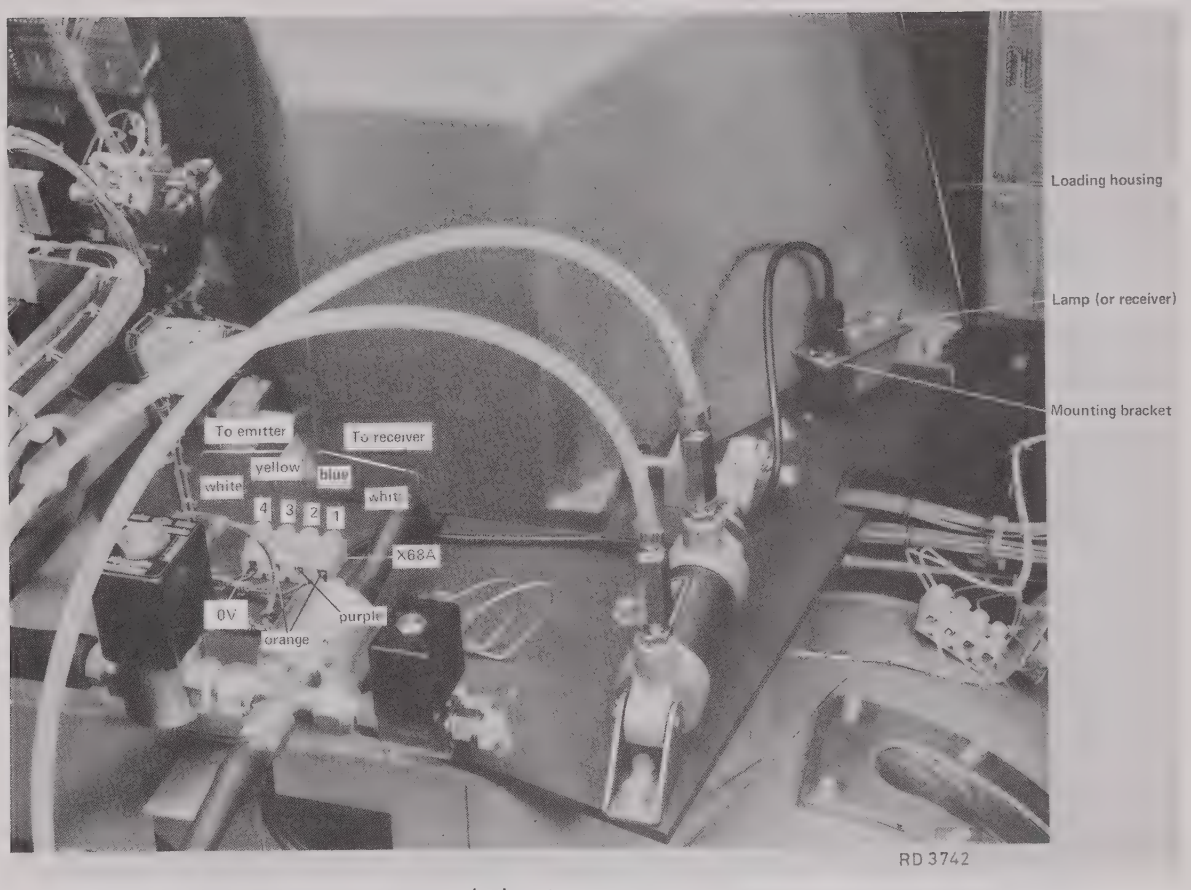


Fig. 3.21.2.2. Fitting the spectrometer sample detector

Fig. 3.21.2.3. Spectrometer connectors to sample loader/changer

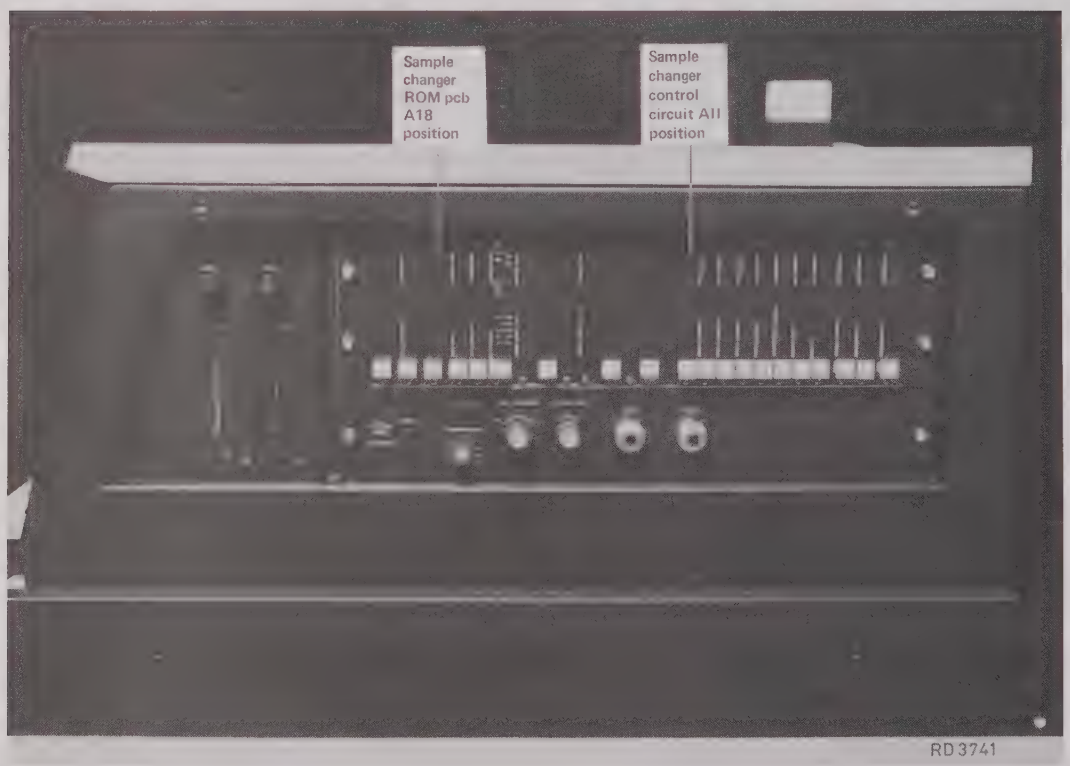


Fig. 3.21.2.4. Changer control pcb position in the spectrometer

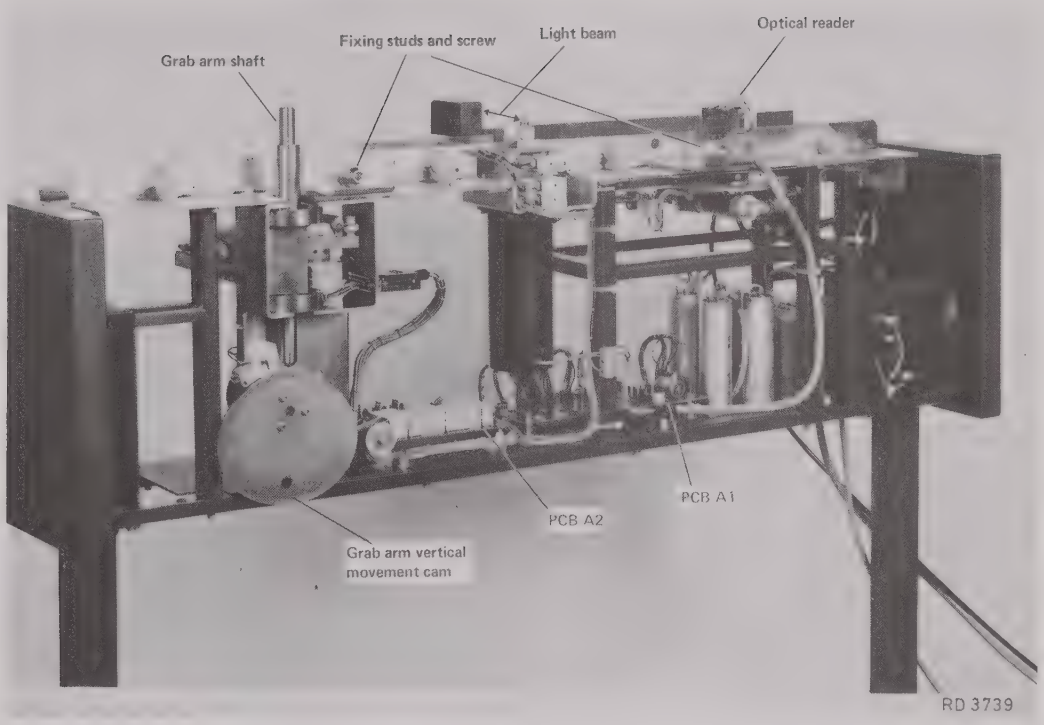


Fig. 3.21.2.5. Sample loader — covers removed

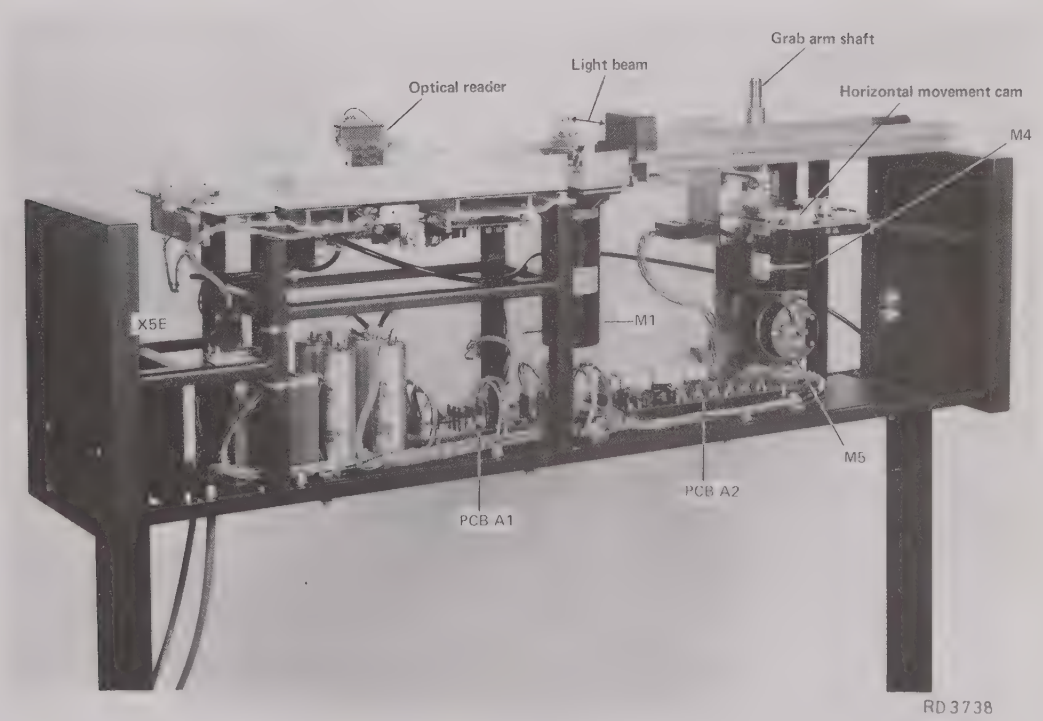


Fig. 3.21.2.6. Sample loader frontside

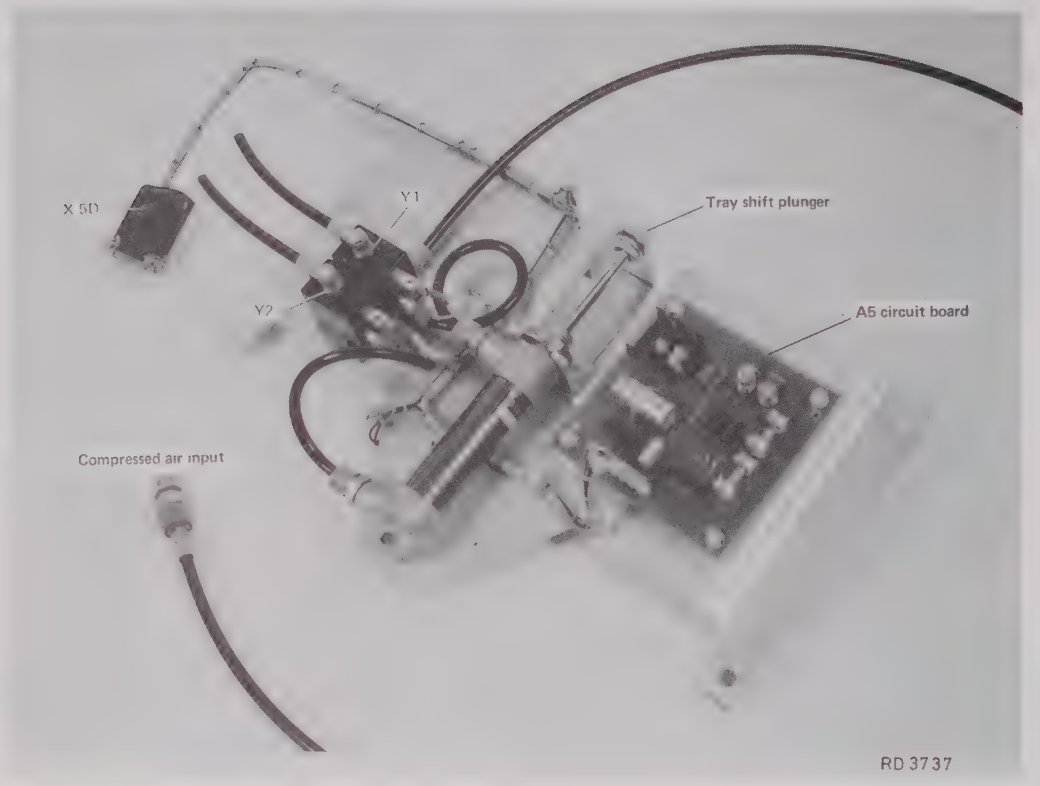


Fig. 3.21.2.7. PW1505/00 Reference tray option, PW1506/00 12-position option

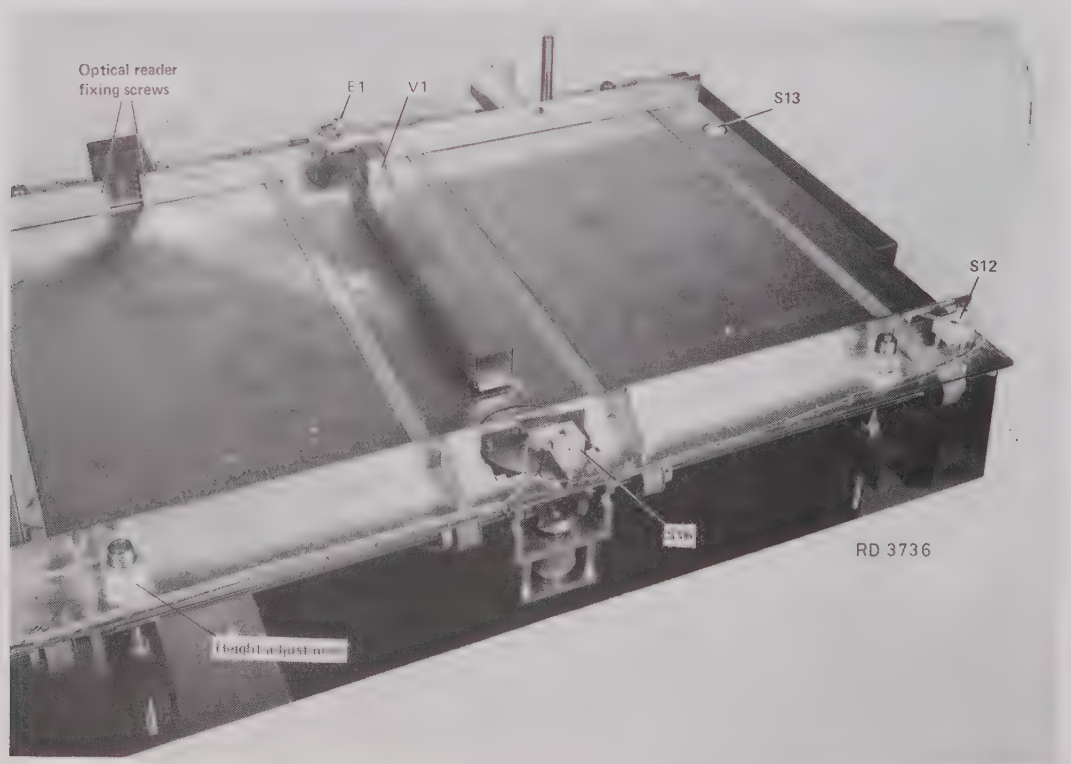
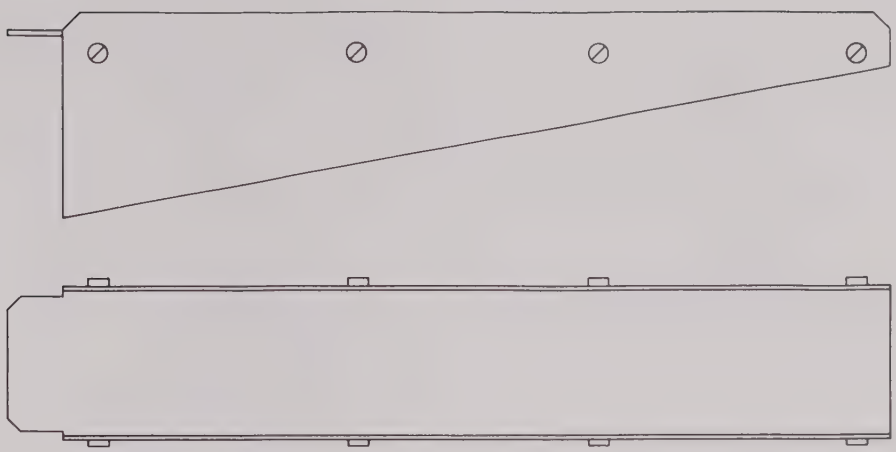
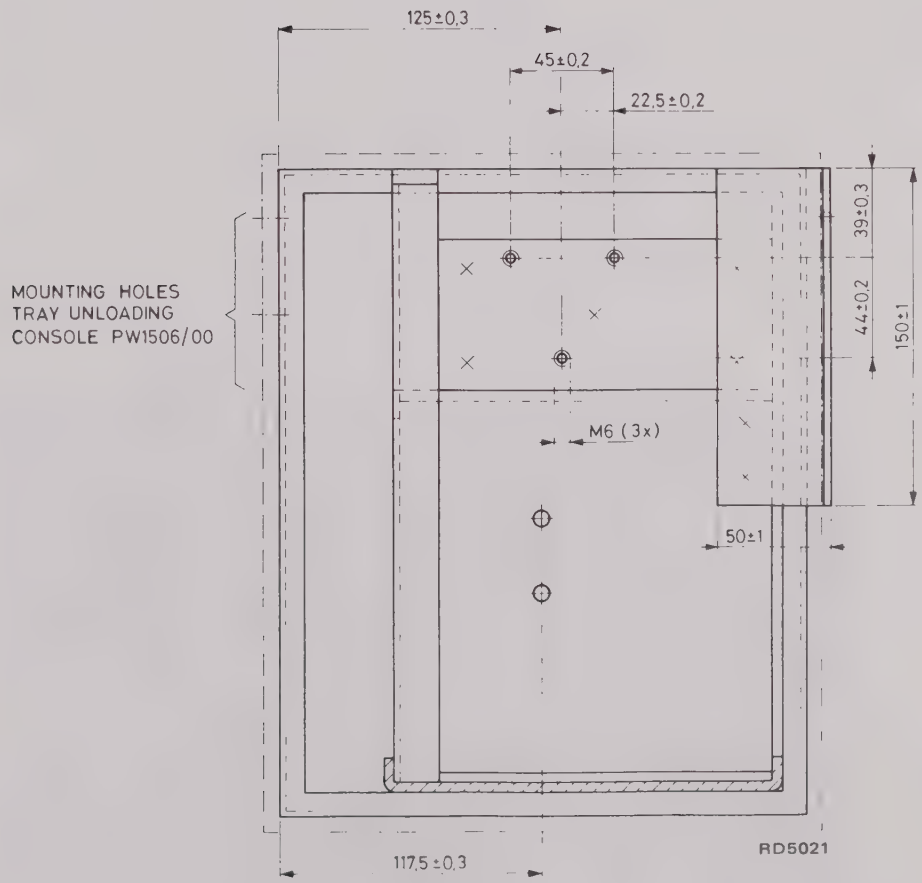


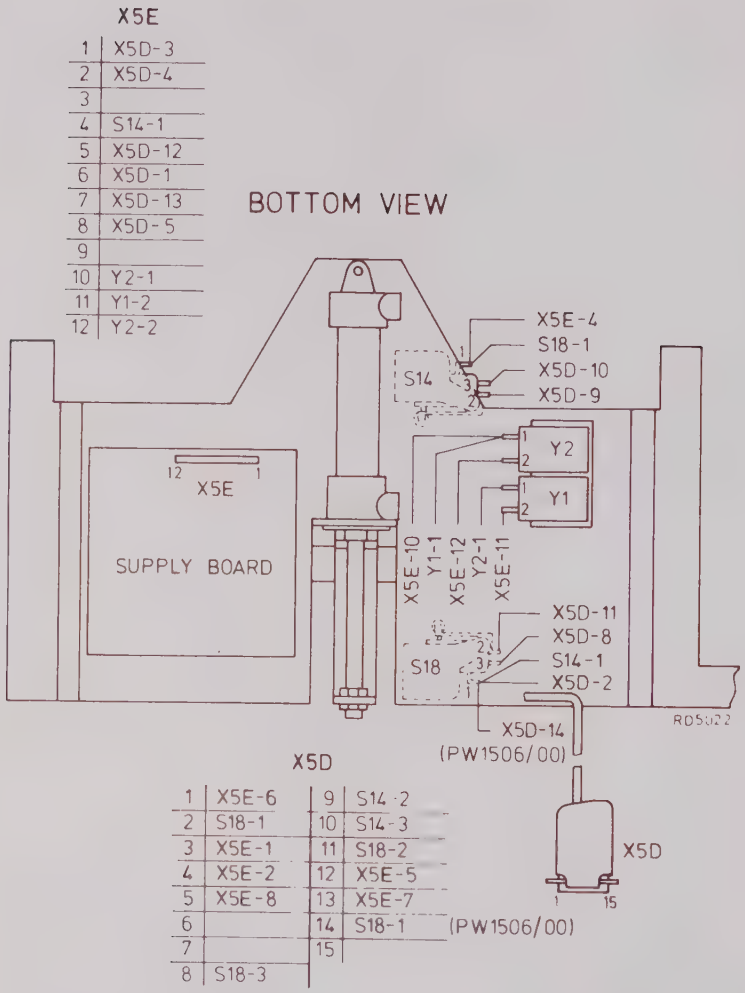
Fig. 3.21.3.1. Sample changer from the front - covers removed.



TRAY UNLOADING CONSOLE
PW1506/00



Mounting holes for the PW 1506/00



PW 1505 wiring and cable connection

3.21.3. Fitting the PW1500/10/15/16 Sample Changer

Before installing the sample changer switch off the mains power to the spectrometer. Fit the detection system at the spectrometer loading hole as described in paragraph 3.21.2. "PW1400 Spectrometer".
A compressed air supply is not required for the sample changer operation.

Fit the sample changer control pcb in position A11 and the sample changer ROM pcb in position A18 of the rack at the right-hand side of the spectrometer (see figure 3.21.2.4.), but first check that the jumper connections are as shown in table 3.21.2.1.

Before fixing the sample changer to the spectrometer, the covers should be removed as necessary.

- The lower front panel and the lower rear panel are secured at the bottom by 4 x 6 mm screws.
- The upper front panel can now be removed by withdrawing the two 4 mm hexagon-headed screws, visible when the lower panel is removed.
- If the upper rear panel is to be removed, the grab arm and the optical reader cover must be removed first (held by two screws), see figure 3.21.3.1.
- To obtain access to the sample changer printed circuit boards remove the cover (see figure 3.21.3.3.) by withdrawing the 5 mm screws (1), and the 3 mm screws (2) from below the bottom frame plate.
  It is preferable to check the mechanical operation of the sample changer before further installation.
- Connect the 220 volt supply and signal control cable connectors to the X110 and X111 socket at the front lower right of the spectrometer cabinet – figure 3.21.2.3.
- Place a sample tray, containing one or more sample holders, in the sample changer. A tray identification card showing at least the tray identification, should be placed in the slot in front of the tray.
- Switch on the spectrometer (H.T. not necessary) and test the sample changer functions using the procedure described in paragraph 7.6.1. Alternatively use the software commands, as described in paragraph 7.6.3.
  In the event that any adjustment of the tray transport or grab arm movement is necessary refer to paragraph 3.21.4.
- If the functional checks are satisfactory the level of the sample changer platform should be adjusted until the two location studs and screws are level with the mating fixing holes in the spectrometer, see figure 3.21.3.2.

Check platform alignment – before attempting to level the tray platform, or carry out any adjustments, ensure that the transport brackets, (1) and (2) figure 3.21.3. (a), are loosened.

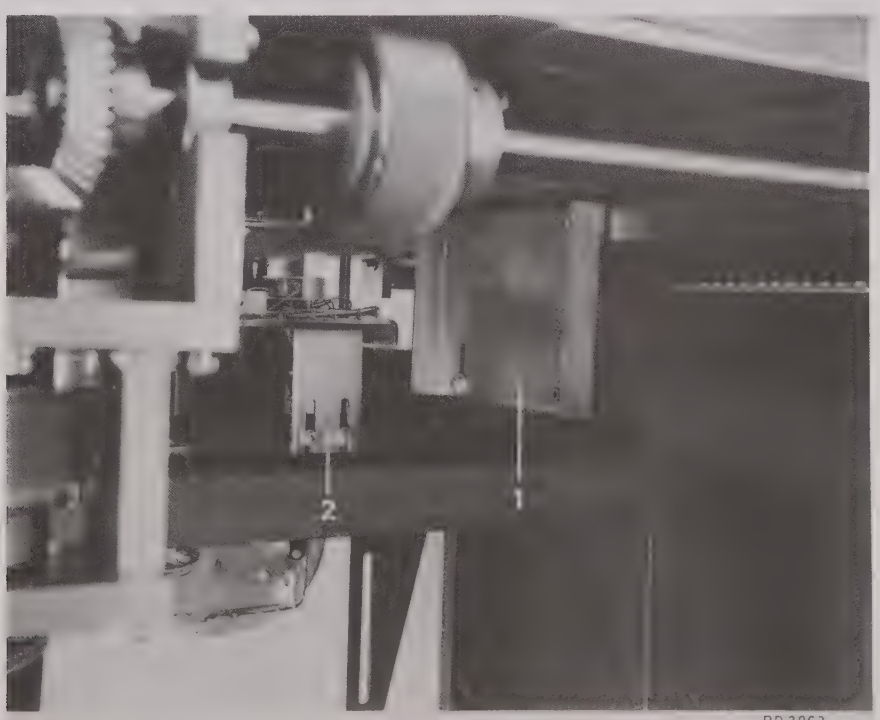


Figure 3.21.3(a) Platform support brackets

When the sample changer assembly is wheeled in front of the spectrometer the platform height can be roughly adjusted by means of the nuts (29) on the threaded rod (30). Now loosen nut (20) and use a 16 mm hexagonal key in the threaded bush (28) to make fine adjustments. Similar adjustments may also be necessary at the front of the changer. Use a spirit level to check that the sample changer platform is level.

- Fix the sample changer to the spectrometer with the 6 mm screws supplied.
- Make final adjustments to level the platform with the bushes (28), and tighten the lock nuts (20).
- Repeat the functional checks.
- Replace the covers.

The sample changer is now ready for normal operation, and the loading of a sample into the spectrometer and the unloading operation, should be checked. Adjustment of the grab arm is described in paragraph 3.21.4.1.

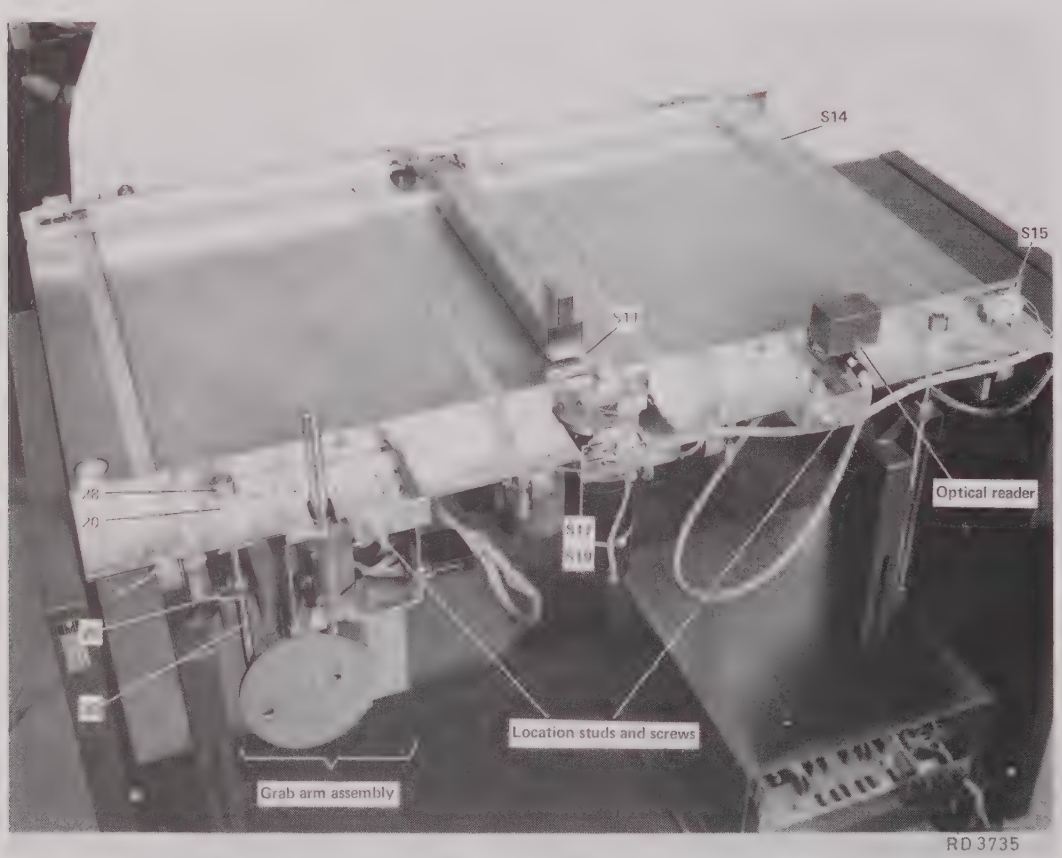


Fig. 3.21.3.2. Sample changer from the spectrometer side - covers removed.

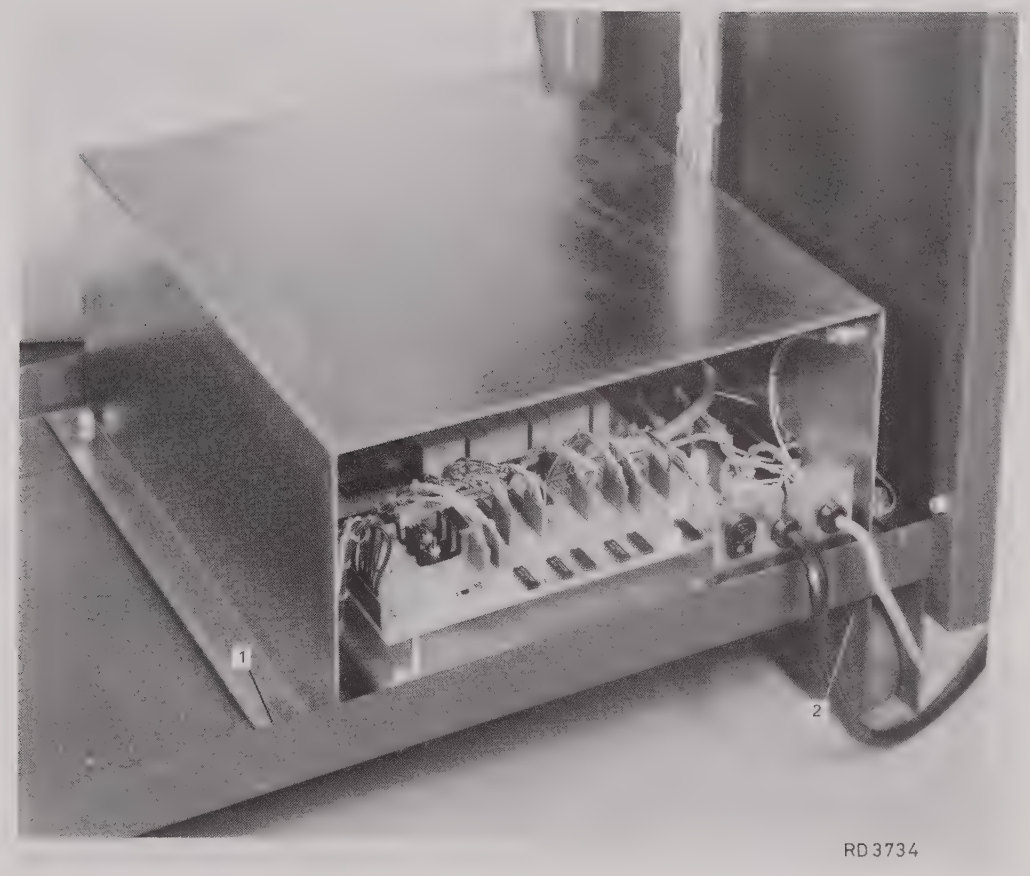


Fig. 3.21.3.3. Sample changer electronic unit.

PW1500/00 Sample Loader

Before fixing the sample loader to the spectrometer the covers should be removed as necessary, and the assembly must be mounted on the trolley legs.

- The front panel is secured from below by four screws.
- The left-hand side panel is secured by four screws.
- If required, the rear panel can be removed after the optical reader cover (secured by two screws) and the grab arm have been removed, see figures 3.21.2.5. and 3.21.2.6.
- The upper surface of a sample holder in the loading position in the sample loader must be parallel with the upper surface of a sample holder in the loading opening of the PW1400/00 within a total tolerance of 0,5 mm. If necessary, adjust the legs of the sample loader to achieve this.

It is preferable to check the mechanical operation of the sample loader before further installation.

- Connect the 220 volt supply and signal control cable connectors to the X110 and X111 at the front lower right of the spectrometer cabinet.
- Place a sample tray, containing a sample holder in position 1, at the left-hand end loading position.
- Switch on the spectrometer (H.T. not necessary) and test the loader functions using the procedure described in paragraph 7.6., or the software commands LTU i and UTU i, MTY i, and FRT and SRT. In the event that any adjustment of the tray transport or grab arm movement is necessary refer to paragraph 3.21.4.
- If the functional checks are satisfactory adjust the height of the assembly on the legs so that the two location studs and screws are slightly higher than the mating fixing holes in the spectrometer. Fine adjustment of the height is now possible by adjustment of the star-shaped screws (59) shown in figure 8.5.7.(a).
- Fix the loader to the spectrometer with the 6 mm screws supplied.
- Repeat the functional checks as above.
- Replace the covers, the grab arm, and the optical reader cover.
- Check that sample loading/unloading is correct.

The sample loader is now ready for normal operation.

PW1505/00 Reference Tray option, PW1506/00 12-position option

This option can be added to the sample loader to enable a tray of reference, or other, samples to be stored ready for use when another sample tray is in the loading position. When the measured sample tray is removed, the reference tray command FRT is given to bring the reference tray to the loading position.

Fit the option (see figure 3.12.2.7.) to the leader assembly as follows:

- Remove the loader front cover, see above.
- Remove the cover [62, see fig. 8.5.7.(a)], and the bottom plate which is secured with the screws [64] and the spacers [66].
- Slide the PW1505/00 or PW1506/00 between the loading platform and the loader framework and fix it in position using the existing screws, washers and spacers – items 63, 64 and 66 of figure 8.5.7.(a).
- Check that the tray shift plunger is free to move the bracket freely on the loading platform.
- Adjust the position of the microswitches S14 and S18 so that they are operated by the movement of the tray shift bracket – see figure 8.5.8.
- Microswitch S11 should be adjusted so that it operates well before S14 is operated. Incorrect switching will produce an error situation.
- At the spectrometer fit the air hose supply as described in paragraph 3.21.2.
- Plug in the air hose connector from the PW1505 to the spectrometer quick-release connection.
- Connect the plug X5E to the connector X5D, see figure 3.21.2.6.
- When the system is operational, give the commands FRT and SRT to check the reference tray loading and unloading operations.
- Adjust the compressed air restrictions [fig. 2.21.2.7. item 70] so that a movement takes between 1 and 2 seconds with an air pressure of 4 atm. For smooth operation the normal operating pressure should be 3,5-4 atm.

3.21.4. Mechanical adjustments

When adjustment of the mechanical operation of the sample loader or changer is required, the covers should be removed as necessary, and the normal precautions regarding contact with the electrical mains supply should be observed.
Detach the sample loader/changer from the spectrometer if required.

3.21.4.1. *Grab arm*

The height of the vertical movement of the grab arm, the sample holder pickup positions and the swing of the arm can be adjusted, see figures 3.21.4.1.1. and 3.21.4.1.2.

Height of the vertical movement

The height of the grab arm can be adjusted so that the grab correctly engages with the sample holder before lifting the sample from the tray or the spectrometer loading hole. Proceed as follows:
- Place a tray with a sample holder in the loading position of the loader or changer.
- Move the grab arm manually by turning the horizontal movement cam until the L-shaped lips of the grab engage the sample holder. The distance between the lower edge of the holder rim and the lip of the grab arm should be approximately 1.5 mm.
- If adjustment is required, loosen the clamp screw B of arm clamp on the shaft. The height adjustment can now be made with screw 'A'.
- Tighten the clamp screw 'B'.

Vertical movement adjustment – the shaft [20] should be exactly perpendicular to the tray plaform and the level of the spectrometer loading hole. Check that the grab arm lifts without any horizontal displacement by checking with a T-square that any movement is less than 0,5 mm. If necessary, adjust the plates [item 34] on shaft [20] . Any play at the top of the shaft must be less than 0,2 mm when the end of the grab arm is displaced (weighted) by hand.
Refer to figure 8.5.6.

Horizontal adjustment (sample tray)

The horizontal position at which the grab arm picks up the sample holder from, or replaces it in, the sample tray, can be adjusted as follows:
- Place a tray with a sample holder in the loading position.
- Rotate the horizontal movement cam in an anti-clockwise direction to position the grab arm in the most forward position, to pick up the sample holder from the tray.
- If the position is not central and correct, loosen the clamp screw 'B' of the arm clamp on the shaft.
- Move the grab arm position relative to the drive shaft so that the grab can pick-up or replace a holder in the tray, without horizontal movement of the sample holder.
- Tighten the clamp screw 'B'.
- Check that the vertical adjustment is unchanged – see above.

Horizontal adjustment (spectrometer)

The horizontal position at which the grab arm inserts the sample holder into, or picks it up from, the spectrometer loading hole can be adjusted by varying the span distance of the horizontal movement. The span is preset before despatch from the factory, but if adjustment is required proceed as follows:

Alignment of mechanism – the relative positions of the changer to the spectrometer are shown in figure 5.21.4.1.(a).

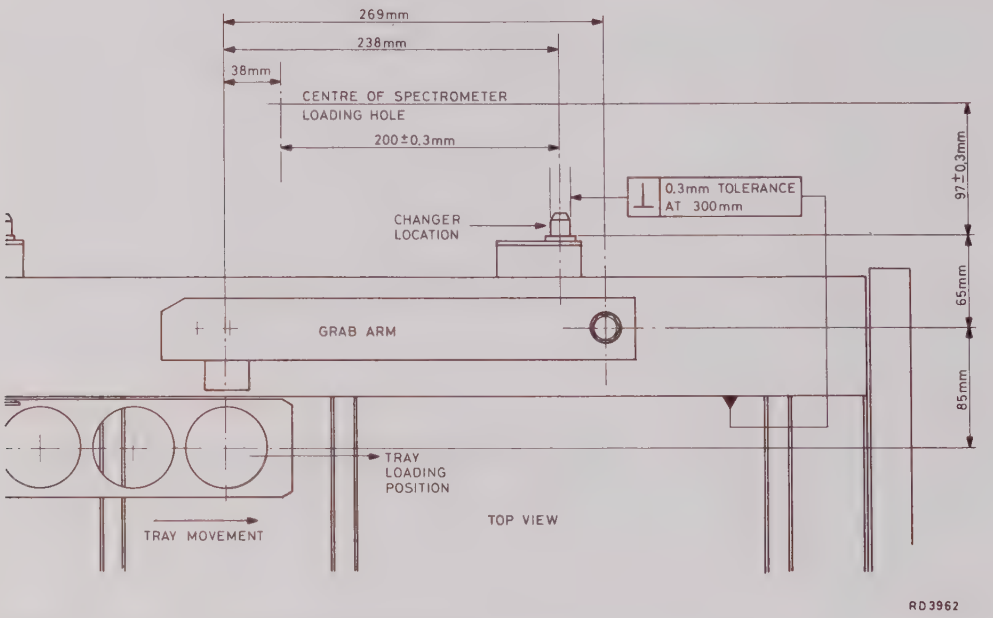


Figure 5.21.4.1.(a). Positioning of grab arm

- The loader/changer must be fixed to the spectrometer.
- Place a tray with a sample holder in the loading position.
- Move the grab arm to the spectrometer loading hole position by rotating the horizontal movement cam in an counter clockwise direction.
- Move the grab vertically by rotating the vertical movement cam, to load the holder into, or unload it from the loading hole. The holder should be central in the hole and not touch the sides.

Adjustment of sample claws – the assembly of the claws on the grab arm is shown in figure 3.21.4.1.(b). The force to hold a sample is adjusted by the nuts [item 6], and the claws must remain in place when a force of 60 [+10] grams is applied.

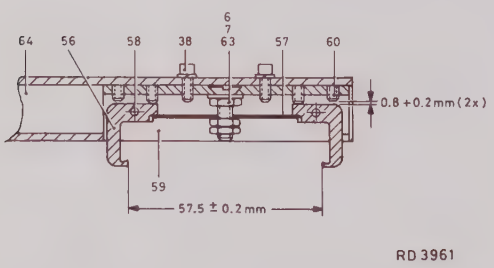


Figure 3.21.4.1.(b). Grab arm claws assembly

- Place a tray in the loading position of the changer.
- Rotate the disc assembly [67, 68] of the grab arm mechanism until the claws are in position to pick up a sample cup from the tray.
- Adjust the claws bracket as necessary by the screws [38], so that the sample cup is central between the claws.
- Check the adjustment of the load/unload action at the sample tray, and readjust as necessary.
- Finally check all grab arm movements for correct operation, including the vertical movement of the grab arm.

Adjustment of swing – the length between the centres of the two pivots should be adjusted to 105 ± 0,2 mm, see figure 4. Final adjustment the swing of the grab arm can be made by moving the brackt [71] on the square rod [44].

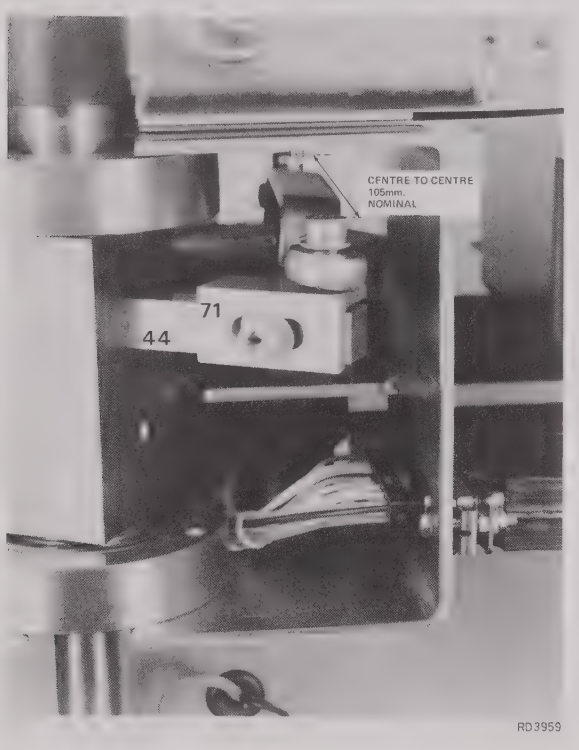


Figure 3.21.4.1.(c). Grab arm swing adjustment

Adjustment of tray position pawl – this pawl is positioned at the left side of the light beam detector at the tray loading position, and serves to guide the tray to engage with the studs on the tray shift disc. The pawl is shown as [item 68] of figure 8.5.9.
The pawl is spring loaded [item 69] to move with a light pressure, but if free movement is not possible the tray can jam or be damaged.
Modify the pawl assembly to fit a spring washer between the tray platform and the pawl, to prevent dust particles on the platform from affecting the pawl operation.

Spring washer – phosphor bronze 5,2 mm dia, service 4822 530 80037.

Check microswitch pressure – the spring load should be greater than 50 grams. Tray transport faults can be caused if the pressure is too low, therefore it may be necessary to fit new switches. Service stock has been checked to ensure that the microswitches have the correct pressure.

Mechanical fault conditions and their correction [fig. 8.5.6.]

- If the angular movement of the grab arm has been correctly adjusted and the sample holders are properly picked up from the tray but strike the edge of the tray when they are replaced, carry out the following procedure:
  Check that the grab arm moves freely in the vertical direction.
  Place a set-quare on the platform around the loading opening on the spectrometer and cause the grab arm to move vertically up and down by rotating the lift cans so that the end of the grab arms can be checked with the set-square. The distance between the set-square and the arm must not vary by more than 0,5 mm over the whole vertical range.
  If this condition is not met, adjust the guide strips [34] on the arm mechanism bearing block. There must be practically no play between the bearing [24] and the guide strips. The maximum play at the end of the arm may not exceed ± 0,2 mm.
- If the angular movement of the grab arm cannot be correctly adjusted, check carefully the disctance between the centre of the spectrometer loading opening and the right-hand location stud on the back of the sample loader/changer. The relevant dimensions are 200 ± 0,3 mm and 97 ± 0,3 mm [see fig. 5.21.4.1.(a).
- If the grab arm picks up the sample holder correctly from the tray on the sample loader/changer but fails to place it correctly in the loading opening of the spectrometer, adjust the three set-screws in the frame on which the vertical shaft of the grab arm mechanism is mounted.

3.21.4.2. *Tray movement (PW1500/00/15/16 + PW1505/00 and (PW1500/15/16 and PW1506/00)*

Check that the platform is flat and level, and that the tray movement from the reference tray option (if fitted) is smooth, see paragraph 3.21.2.
Check that the PW1505/PW1506 microswitch S13 (figure 8.3.2.3.) operates just before microswitch S11 (figure 8.3.2.2.).

3.21.4.3. *Sample changer tray movement*

Check that the platform is level and that tray movement is smooth and correct when the procedure described in paragraph 7.6.1. is followed.

Ensure that when a tray operates microswitch S15 (figure 8.3.3.1.) the loading position of the tray is correct, particularly when tray movement from right to left is selected.

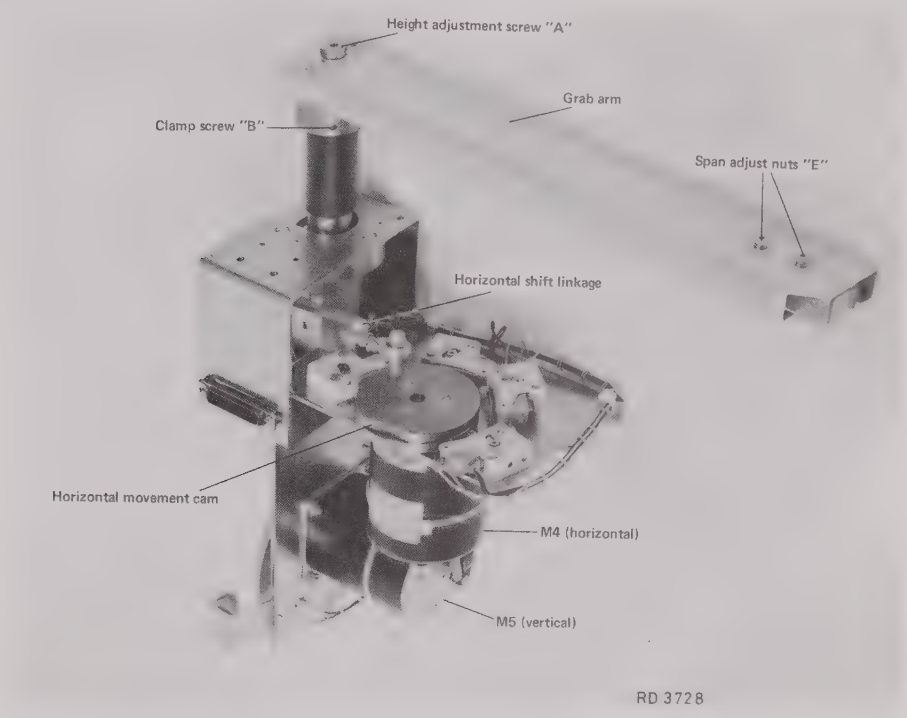


Fig. 3.21.4.1.1. Grab arm assembly - horizontal cam.

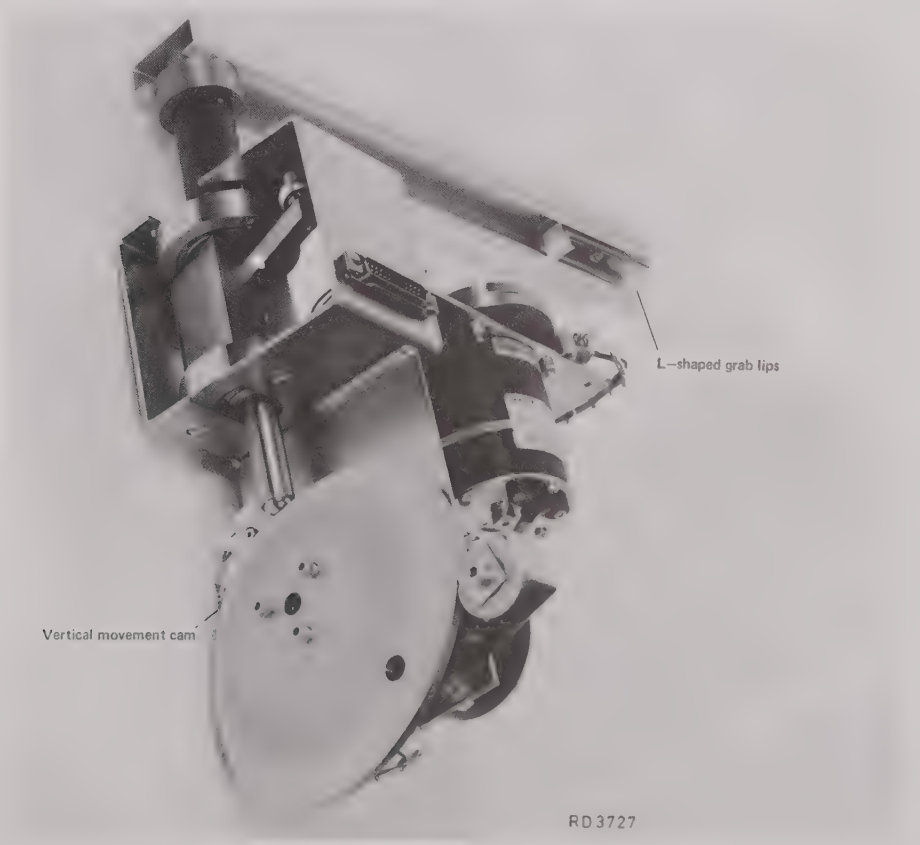


Fig. 3.21.4.1.2. Grab arm assembly - vertical cam.

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4. ELECTRICAL DESCRIPTION

4.1. INTRODUCTION

This chapter contains a complete description of the electrical and electronic circuits of the PW1400/00. It is arranged in six main parts:

General information

Microcomputer system

Measuring system

Control system

Power supplies

Sample loader and sample changer.

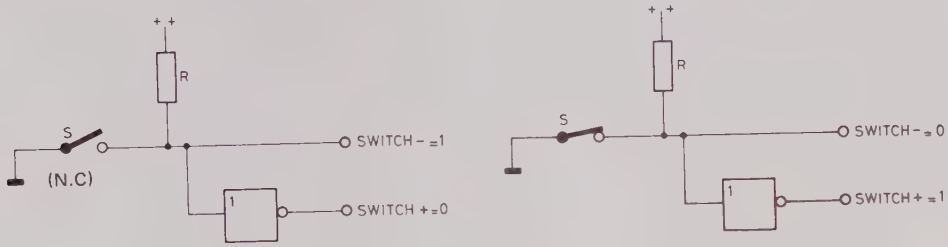
The electronic circuits are based on a number of printed circuit boards, each of which performs a separate function. For this reason the main parts are broken down into descriptions of the various functions.

4.1.1. DRAWING SYMBOLS AND CONVENTIONS

The circuit descriptions and diagrams have signal names which are intended to indicate the function of a particular part of the circuit, and these signal names are listed in the table of mnemonics in paragraph 4.1.2. The signal name is usually followed by a polarity sign to indicate:-

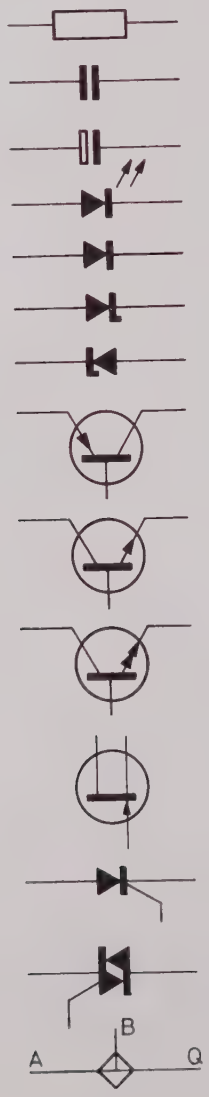
+ signal true when it is high (= 1) (H) = +5 V, +12 V, −12 V or the transition from low to high (↑)
− signal true when it is low (= 0) (L) = 0 V or the transition from high to low (↓)

For example:-



Component symbols

These are listed below:-



Resistor

Capacitor

Capacitor - electrolytic

Light emitting diode (LED)

Diode

Stabistor

Zener diode

PNP Transistor

NPN Transistor

NPN Darlington transistor

Field effect transistor

Thyristor

Triac

Wired AND gate

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

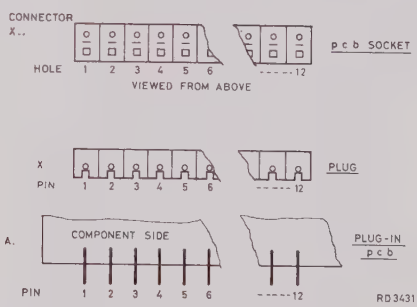
Contactor (single winding) and associated contacts

Relay (single winding)

Relay contacts

Push-button switch contacts ≡

CIS connector



INTEGRATED CIRCUITS.

General description of LOCMOS

The LOCMOS HEF4000 range is a digital integrated circuit family, and LOCMOS means: Local Oxidation Complementary MOS.
The main effect of LOCMOS is a considerable reduction in the chip area required for a given function. Also important is the reduction in stray capacitance due to the smaller contact areas-hence the higher switching speed. Another benefit, brought about by the manufacturing process, is the self-alignment of the source and drain diffusions. This means that tolerance margins in the diffusions are unnecessary, thus further reducing the stray capacitances.

Advantages of C-MOS:

- low power dissipation - typically 10 nW per gate (static);
- wide operating supply voltage range;
- high noise immunity;
- wide operating temperature range - −40 to + 85°C;
- high d.c. fan-out;
- inputs and outputs are protected against electrostatic voltages.

In addition to these, LOCMOS has:

- buffered outputs on all circuits;
- higher speed;
- higher packing density - essential for MSI/LSI;
- better noise immunity.

The HE family is designed with standardized output drive characteristics which, combined with relative insensitivity to output capacitance loading, simplify system design. The recommended supply voltage range is 3 to 15 volts. The type number has a suffix P, which denotes a plastic dual in-line configuration, and a D will indicate a ceramic (cardip) package.

HE family ratings

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	V_{DD}	−0,5 to + 18 V
Voltage on any input	V_I	−0,5 to V_{DD} + 0,5 V*)
Current into any input	$\pm I_I$ max.	10 mA
Power dissipation (per package)	P_{tot} max.	400 mW
Operating ambient temperature	T_{amb}	−40 to + 85 °C
Storage temperature	T_{stg}	−65 to + 150 °C

HE family characteristics (d.c.) at V_{SS} = 0 V

* $V_{DD} \leqslant 18V$

	Symbol	T_{amb} = −40°C min.	max.	T_{amb} = +25°C min.	max.	T_{amb} = +85°C min.	max.	Conditions V_{DD}	
Input voltage HIGH	V_{IH}	3,5	5	3,5	5	3,5	5 V	5	
		7,0	10	7,0	10	7,0	10 V	10	
		10,5	15	10,5	15	10,5	15 V	15	
Input voltage LOW	V_{IL}	0	1,5	0	1,5	0	1,5 V	5	
		0	3,0	0	3,0	0	3,0 V	10	
		0	4,5	0	4,5	0	4,5 V	15	
Output voltage HIGH	V_{OH}	4,99	–	4,99	–	4,95	– V	5	
		9,99	–	9,99	–	9,95	– V	10	note 1
		14,99	–	14,99	–	14,95	– V	15	
Output voltage HIGH	V_{OH}	4	–	4	–	4	– V	5	
		9		9	–	9	– V	10	note 2
		13	–	13	–	13	– V	15	
Output voltage LOW	V_{OL}	–	0,01	–	0,01	–	0,05 V	5	
		–	0,01	–	0,01	–	0,05 V	10	note 1
		–	0,01	–	0,01	–	0,05 V	15	
Output voltage LOW	V_{OL}	–	0,5	–	0,5	–	0,5 V	5	
		–	1,0	–	1,0	–	1,0 V	10	note 2
		–	2,0	–	2,0	–	2,0 V	15	
Output current HIGH	$-I_{OH}$	0,7	–	0,7	–	0,4	– mA	5	
		1,4	–	1,4	–	0,8	– mA	10	note 3
		2,2	–	2,2	–	1,4	– mA	15	
Output current HIGH	$-I_{OH}$	1,5	–	1,5	–	1,0	– mA	5	note 4
Output current LOW	I_{OL}	1,0	–	0,8	–	0,4	– mA	5	
		2,6	–	2,0	–	1,2	– mA	10	note 5
		3,6	–	3,6	–	2,0	– mA	15	
Input leakage current	I_{IN}	–	–	–	100	–	– nA	5	
		–	–	–	100	–	– nA	10	note 6
		–	–	–	1000	–	– nA	15	

1. I_{OH} = 0; inputs at 0 V or V_{DD}.
2. I_{OH} = 0; inputs at specified worst case conditions.
3. $V_O = V_{DD}$ −0,5V; inputs at 0 V or V_{DD}.
4. V_O = 2,5 V; inputs at o V or V_{DD}.
5. V_O = 0,4 V at V_{DD} = 5 V; V_O = 0,5 V at V_{DD} = 10 V and 15 V; inputs at 0 V or V_{DD}.
6. Pin under test at 0 V or V_{DD}; all other inputs simultaneously at 0 V or V_{DD}.

Handling MOS devices

Though all MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental over-voltages. In storing and handling them, the following precautions are recommended.

1. Store and transport the circuits in their original packing. Alternatively, use may be made of a conductive material or special IC carrier that either short-circuits all leads or insulates them from external contact.

   Caution Points 2 and 3 call for special attention to personal safety.
   Personnel handling MOS devices should normally be connected to ground via a resistor.

2. Work on a conductive surface (e.g. metal table top) when testing the circuits or transferring them from one carrier to another. Electrically connect the person doing the testing or handling to the conductive surface, for example by a metal bracelet and a conductive cord or chain. Connect all testing and handling equipment to the same surface.

3. Mount MOS integrated circuits on printed circuit boards after all other components have been mounted. Take care that the circuits themselves, metal parts of the board, mounting tools, and the person doing the mounting are kept at the same electric (ground) potential. If it is impossible to ground the printed-circuit board the person mounting the circuits should touch the board before bringing MOS circuits into contact with it.

4. Soldering iron tips, including those of low-voltage irons, or soldering baths should also be kept at the same potential as the MOS circuits and the board.

5. After the MOS circuits have been mounted on the board proper handling precautions should still be observed. Until the sub-assemblies are inserted into a complete system in which the proper voltages are applied, the board is no more than an extension of the leads of the devices mounted on the board. To prevent static charges from being transmitted through the board wiring to the device it is recommended that conductive clips or conductive tape be put on the circuit board terminals.

6. To prevent permanent damage due to transient voltages, do not insert or remove MOS devices, or printed-circuit boards with MOS devices, from test sockets or systems with power on.

7. Beware of voltage surges due to:
   - switching electrical equipment on or off;
   - relays;
   - d.c. lines.

8. Signals should not be applied to the inputs while the device power supply is off.

9. All unused input leads should be connected to either the supply voltage or ground.

10. Dress personnel in clothing of non-electrostatic material (no wool, silk or synthetic fibres).

Soldering

1. By hand.

   Apply the soldering iron below the seating plane (or not more than 2 mm above it).
   If its temperature is below 300°C it must not be in contact for more than 10 seconds; if between 300°C and 400°C, for not more than 5 seconds.

2. Repairing soldered joints

   The same precautions and limits apply as in (1) above.

Selection guide by function

NAND gates	HEF4011P	quadruple 2-input NAND gate
	HEF4012P	dual 4-input NAND gate
	HEF4023P	triple 3-input NAND gate
	HEF4068P	8-input NAND gate
AND gates	HEF4073P	triple 3-input AND gate
	HEF4081P	quadruple 2-input AND gate
	HEF4082P	dual 4-input AND gate
NOR gates	HEF4000P	dual 3-input NOR gate and inverter
	HEF4001P	quadruple 2-input NORT gate
	HEF4002P	dual 4-input NOR gate
	HEF4025P	triple 3-input NOR gate
	HEF4078P	8-input NOR gate
OR gates	HEF4071P	quadruple 2-input OR gate
	HEF4072P	dual 4-input OR gate
	HEF4075P	triple 3-input OR gate
Inverters and buffers	HEF4007P	dual complementary pair and inverter
	HEF4041P	quadruple true/complement buffer
	HEF4049P	hex inverting buffer
	HEF4050P	hex non-inverting buffer
	HEF4069P	hex inverter
	HEF40097P	3-state hex non-inverting buffer
	HEF40098P	3-state hex inverting buffer
Complex gates	HEF4030P	quadruple EXCLUSIVE-OR gate
	HEF4070P	quadruple EXCLUSIVE-OR gate
	HEF4085P	dual 2-wide 2-input AND-OR-invert gate
	HEF4086P	4-wide 2-input AND-OR-invert gate
Flip-flops	HEF4013P	dual D-type flip-flop
	HEF4027P	dual JK flip-flop
	HEF40174P	hex D-type flip-flop
	HEF40175P	quadruple D-type flip-flop
Counters	HEF4017P	5-stage Johnson counter
	HEF4018P	presettable divide-by-n counter
	HEF4020P	14-stage binary counter
	HEF4022P	4-stage divide-by-8 Johnson counter
	HEF4024P	7-stage binary counter
	HEF4029P	synchronous up/down counter, binary/decade counter
	HEF4040P	12-stage binary counter
	HEF4510P	BCD up/down counter
	HEF4516P	binary up/down counter
	HEF4518P	dual BCD up counter
	HEF4520P	dual binary up counter
	HEF4737P	quadruple static decade counter
	HEF40192P	4-bit up/down decade counter
	HEF40193P	4-bit up/down binary counter

Registers	HEF4006P	18-stage static shift register
	HEF4014P	8-bit shift register
	HEF4015P	dual 4-bit static shift register
	HEF4021P	8-bit shift register
	HEF4031P	64-stage static shift register
	HEF4035P	4-bit universal shift register
	HEF40194P	4-bit bidirectional universal shift register
	HEF40195P	4-bit universal shift register
Decoders	HEF4028P	1-of-10 decoder
	HEF4511P	BCD to 7-segment latch/decoder/driver
	HEF4514P	1-of-16 decoder/demultiplexer with input latches
	HEF4515P	1-of-16 decoder/demultiplexer with input latches
	HEF4555P	dual 1-of-4 decoder with active HIGH outputs
	HEF4556P	dual 1-of-4 decoder with active LOW outputs
Encoder	HEF4532P	8-input of priority encoder
Digital multiplexers	HEF4019P	quadruple 2-input multiplexer
	HEF4519P	quadruple 2-input multiplexer
	HEF4539P	dual 4-input multiplexer
Analogue switches and multiplexers/demultiplexers	HEF4016P	quadruple bilateral switches
	HEF4051P	8-channel analogue multiplexer/demultiplexer
	HEF4052P	dual 4-channel analogue multiplexer/demultiplexer
	HEF4053P	triple 2-channel analogue multiplexer/demultiplexer
	HEF4066P	quadruple bilateral switches
	HEF4067P	16-channel analogue multiplexer/demultiplexer
Latches	HEF4042P	quadruple D-latch
	HEF4043P	quadruple R/S latch with 3-state outputs
	HEF4044P	quadruple R/S latch with 3-state outputs
	HEF4724P	8-bit addressable latch
Translators	HEF4104P	quadruple low voltage to high voltage translator with 3-stage outputs
Memories	HEF4720P	256-bit, 1-bit per word RAM
	HEF4721P	1024-bit, 4-bits per word RAM
Multivibrators	HEF4047P	monostable/astable multivibrator
	HEF4528P	dual retriggerable-resettable monostable multivibrator
Arithmetic circuit	HEF4008P	4-bit binary full adder
Schmitt trigger	HEF4093P	quadruple 2-input NAND Schmitt trigger
Phase-locked loop	HEF4046P	micro-power phase-locked loop

Cross-reference guide

HE family types	RCA series A or B	Motorola	Fairchild	National	Solid State Scientific	Texas Instruments
HEF4000P	CD4000A	MC14000	–	–	SCL4000	TP4000
HEF4001P	CD4001A	MC14001	F4001	CD4001	SCL4001	TP4001
HEF4002P	CD4002A	MC14002	F4002	CD4002	SCL4002	TP4002
HEF4006P	CD4006A	MC14006	F4006	CD4006	SCL4006	–
HEF4007P	CD4007A	MC14007	F4007	CD4007	SCL4007	TP4007
HEF4008P	CD4008A	MC14008	F4008	–	SCL4008	TP4008
HEF4011P	CD4011A	MC14011	F4011	CD4011	SCL4011	TP4011
HEF4012P	CD4012P	MC14012	F4012	CD4012	SCL4012	TP4012
HEF4013P	CD4013A	MC14013	F4013	CD4013	SCL4013	TP4013
HEF4014P	CD4014A	MC14014	F4014	CD4014	SCL4014	TP4014
HEF4015P	CD4015A	MC14015	F4015	CD4015	SCL4015	TP4015
HEF4016P	CD4016A	MC14016	F4016	CD4016	SCL4016	TP4016
HEF4017P	CD4017A	MC14017	F4017	CD4017	SCL4017	TP4017
HEF4018P	CD4018A	–	F4018	CD4018	SCL4018	TP4018
HEF4019P	CD4019A	–	F4019	CD4019	SCL4019	TP4019
HEF4020P	CD4020A	MC14020	F4020	CD4020	SCL4020	TP4020
HEF4021P	CD4021A	MC14021	F4021	CD4021	SCL4021	TP4021
HEF4022P	CD4022A	MC14022	F4022	CD4022	SCL4022	TP4022
HEF4023P	CD4023A	MC14023	F4023	CD4023	SCL4023	TP4023
HEF4024P	CD4024A	MC14024	F4024	CD4024	SCL4024	TP4024
HEF4025P	CD4025A	MC14025	F4025	CD4025	SCL4025	TP4025
HEF4027P	CD4027A	MC14027	F4027	CD4027	SCL4027	TP4027
HEF4028P	CD4028A	MC14028	F4028	CD4028	SCL4028	TP4028
HEF4029P	CD4029A	–	F4029	CD4029	SCL4029	TP4029
HEF4030P	CD4030A	–	F4030	CD4030	SCL4030	TP4030
HEF4031P	CD4031A	–	F4031	CD4031	–	–
HEF4035P	CD4035A	MC14035	F4035	CD4035	SCL4035	TP4035
HEF4040P	CD4040A	MC14040	F4040	CD4040	SCL4040	TP4040
HEF4041P	CD4041A	–	F4041	–	SCL4041	TP4041
HEF4042P	CD4042A	MC14042	F4042	CD4042	SCL4042	TP4042
HEF4043P	CD4043A	–	F4043	CD4043	SCL4043	TP4043
HEF4044P	CD4044A	–	F4044	CD4044	SCL4044	TP4044
HEF4046P	CD4046A	MC14046	F4046	–	–	–
HEF4047P	CD4047A	–	F4047	–	–	–
HEF4049P	CD4049A	MC14049	F4049	CD4049	SCL4049	TP4049
HEF4050P	CD4050A	MC14050	F4050	CD4050	SCL4050	TP4050
HEF4051P	CD4051A	–	F4051	CD4051	–	TP4051
HEF4052P	CD4052A	–	F4052	CD4052	–	TP4052
HEF4053P	CD4053A	MC14053	F4053	CD4053	SCL4053	TP4053
HEF4066P	CD4066A	–	F4066	CD4066	–	–
HEF4067P	CD4067B	–	F4067	–	–	–
HEF4068P	CD4068B	–	F4068	–	–	–
HEF4069P	CD4069B	–	F4069	CD4069	–	–
HEF4070P	CD4070B	MC14507	F4070	CD4070	–	–
HEF4071P	CD4071B	–	F4071	–	–	–

HE family types	RCA series A or B	Motorola	Fairchild	National	Solid State Scientific	Texas Instruments
HEF4072P	CD4072B	–	F4072	–	–	–
HEF4073P	CD4073B	–	F4073	–	–	–
HEF4075P	CD4075B	–	F4075	–	–	–
HEF4078P	CD4078B	–	F4078	–	–	–
HEF4081P	CD4081B	–	F4081	–	–	–
HEF4082P	CD4082B	–	F4082	–	–	–
HEF4085P	CD4085B	–	F4085	–	–	–
HEF4086P	CD4086B	–	F4086	–	–	–
HEF4093P	CD4093B	–	–	–	–	–
HEF4104P	–	–	F4104	–	–	–
HEF4510P	CD4510B	MC14510	F4510	–	SCL4510	–
HEF4511P	CD4511B	MC14511	F4511	CD4511	SCL4511	–
HEF4514P	CD4514B	MC14514	F4514	–	SCL4514	TP4514
HEF4515	CD4515B	MC14515	F4515	–	SCL4515	TP4515
HEF4516P	CD4516B	MC14516	F4516	–	SCL4516	–
HEF4518P	CD45180	MC14518	F4518	–	SCL4518	TP4518
HEF4519P	–	MC14519	F4519	–	–	TP4519
HEF4520P	CD4520B	MC14520	F4520	–	SCL4520	TP4520
HEF4528P	–	MC14528	F4528	–	SCL4528	–
HEF4539P	–	MC14539	F4539	–	–	TP4539
HEF4555P	CD4555B	MC14555	F4555	–	–	–
HEF4556P	CD4556B	MC14556	F4556	–	–	–
HEF4720P	CD4061A*)	–	F4720	–	–	–
HEF4721P	–	–	–	–	–	–
HEF4724P	CD4099B*)	–	F4724	–	–	–
HEF40097P	–	–	F40097	CD40097	–	–
HEF40098P	–	–	F40098	CD40098	–	–
HEF40174P	–	MC14174	F40174	CD40174	–	–
HEF40175P	–	MC14175	F40175	CD40175	–	–
HEF40192P	CD40192B	–	F40192	CD40192	–	–
HEF40193P	CD40193B	–	F40193	CD40193	–	–
HEF40194P	CD40194B	MC14194	F40194	–	–	–
HEF40195P	–	–	F40195	CD40195	–	–

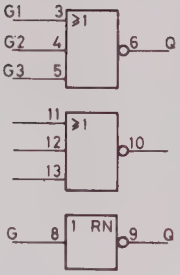
Listing of commonly used LOCMOS integrated circuits.

Type | *Package outline* | *Symbol* | *Truth table*

Symbols used in table listings

x = state is immaterial
⌐ = positive going transition
¬ = negative going transition
1 = high state (the more positive voltage)
0 = low state (the less positive voltage)

HEF4000 Dual 3-input NOR and inverter — 1A (see last page)

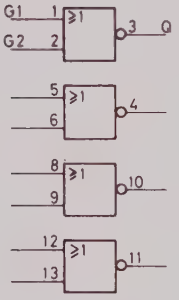


$Q = \overline{G1+G2+G3}$

G1	G2	G3	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

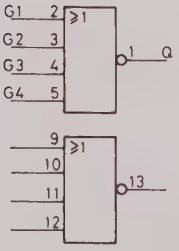
$Q = \overline{G}$

HEF4001 Quad,2-input NOR — 1A



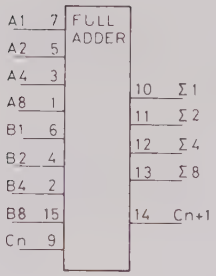
$Q = \overline{G1+G2}$ Similar to above

HEF4002 Dual, 4-input NOR — 1A



$Q = \overline{G1+G2+G3+G4}$ Similar to above

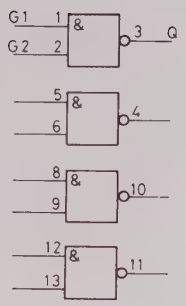
HEF4008 2A
Full ADDER
4-bit binary



To use the table, first find the input row corresponding to A1, B1, A2 and B2. The second set of columns shown the sums (A1 + B1) and (A2 + B2) with an internal carry C2. Now find the input row corresponding to A4, B4, A8 and B8 and the sum result plus the C4 carry is given in the third or fourth set of columns depending on whether the C2 carry was 0 or 1.

INPUT					*OUTPUT*								
Cn	A1	B1	A2	B2	10	11	Carry	C2 = 0			C2 = 1		
	A4	B4	A8	B8	Σ1	Σ2	C2	10 Σ4	11 Σ8	Carry Cn+1	12 Σ4	13 Σ8	14 Carry Cn+1
0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	1	0	0	0	1	0	0	1	0	0	0	1	0
0	0	1	0	0	1	0	0	1	0	0	0	1	0
0	1	1	0	0	0	1	0	0	1	0	1	1	0
0	0	0	1	0	0	1	0	0	1	0	1	1	0
0	1	0	1	0	1	1	0	1	1	0	0	0	1
0	0	1	1	0	1	1	0	1	1	0	0	0	1
0	1	1	1	0	0	0	1	0	0	1	1	0	1
0	0	0	0	1	0	1	0	0	1	0	1	1	0
0	1	0	0	1	1	1	0	1	1	0	0	0	1
0	0	1	0	1	1	1	0	1	1	0	0	0	1
0	1	1	0	1	0	0	1	0	0	1	1	0	1
0	0	0	1	1	0	0	1	0	0	1	1	0	1
0	1	0	1	1	1	0	1	1	0	1	0	1	1
0	0	1	1	1	1	0	1	1	0	1	0	1	1
0	1	1	1	1	0	1	1	0	1	1	1	1	1
1	0	0	0	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	1	0	1	0	0	0	1	0
1	0	1	0	0	0	1	0	1	0	0	0	1	0
1	1	1	0	0	1	1	0	0	1	0	1	1	0
1	0	0	1	0	1	1	0	0	1	0	1	1	0
1	1	0	1	0	0	0	1	1	1	0	0	0	1
1	0	1	1	0	0	0	1	1	1	0	0	0	1
1	1	1	1	0	1	0	1	0	0	1	1	0	1
1	0	0	0	1	1	1	0	0	1	0	1	1	0
1	1	0	0	1	0	0	1	1	1	0	0	0	1
1	0	1	0	1	0	0	1	1	1	0	0	0	1
1	1	1	0	1	1	0	1	0	0	1	1	0	1
1	0	0	1	1	1	0	1	0	0	1	1	0	1
1	1	0	1	1	0	1	1	1	0	1	0	1	1
1	0	1	1	1	0	1	1	1	0	1	0	1	1
1	1	1	1	1	1	1	1	0	1	1	1	1	1

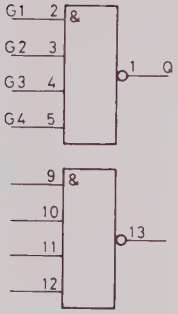
HEF4011 1A
Quad. 2-input NAND



$Q = \overline{G1.G2}$

G1	G2	Q
0	0	1
0	1	1
1	0	1
1	1	0

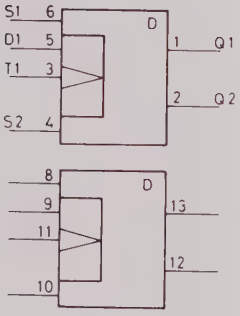
HEF4012 1A
Dual,4-input NAND



$Q = \overline{G1.G2.G3.G4}$

Q = 0 when all G inputs =1, otherwise Q = 1

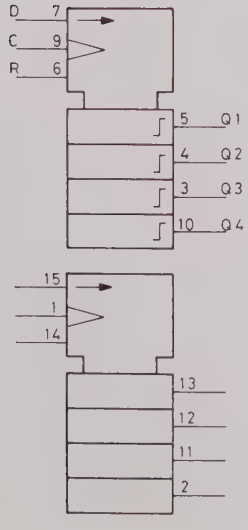
HEF4013 1A
Dual D-type Flip-Flop



Inputs				Outputs	
S1	S2	T1	D1	Q1	Q2
1	0	x	x	1	0
0	1	x	x	0	1
1	1	x	x	1	1
0	0	⌐	0	0	1
0	0	⌐	1	1	0

S1=set, S2=clear, D=data, T=clock

HEF4015 2A
Dual 4-bit static SHIFT REGISTER

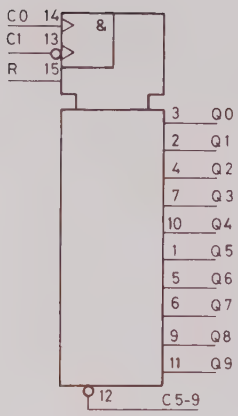


	Inputs			Outputs			
n	C	D	R	Q_1	Q_2	Q_3	Q_4
1	⌐	D_1	0	D_1	x	x	x
2	⌐	D_2	0	D_2	D_1	x	x
3	⌐	D_3	0	D_3	D_2	D_1	x
4	⌙	D_4	0	D_4	D_3	D_2	D_1
	⌐	x	0	No change			
	x	x	1	0	0	0	0

n=number of clock pulse transitions
D_n = data input either high or low

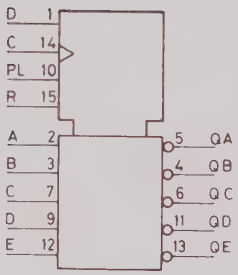
HEF4015 is a serial-to-parallel converter.

HEF4017 2A
5 stage
Johnson
COUNTER



Reset	Clock		
R	C0	C1	Operation
1	x	x	Q0 = C5-9 = 1; Q1 to Q9 = 0
0	1	⌞	Counter advances
0	⌜	0	Counter advances
0	0	x	No change
0	x	1	,, ,,
0	1	⌜	,, ,,
0	⌞	0	,, ,,

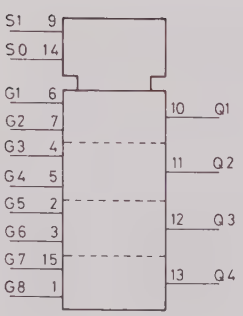
HEF4018 2A
Pre-settable
DIVIDE
BY–N
COUNTER



The HEF4018 is a 5-stage Johnson counter.
Information on inputs (A–E) is asynchronously loaded into the counter while PL is high, independent of the data input (D) and master reset (R) input.
By connecting the Q output to the D input, the counter operates as a divide-by-n counter- see table.

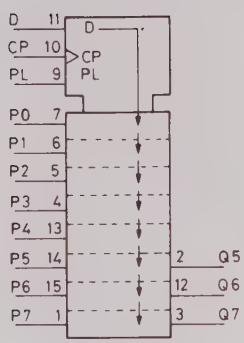
Divide by	Connect to D input
2	Q_A
3	Q_A, Q_B
4	Q_B
5	Q_B, Q_C
6	Q_C
7	Q_C, Q_D
8	Q_D
9	Q_D, Q_E
10	Q_E

HEF4019 2A
Quad, 2-input
MULTIPLEXER



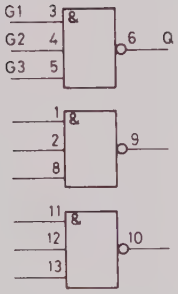
Select		Inputs		Output
S1	S0	G_{odd}	G_{even}	
0	0	x	x	0
1	0	0	x	0
1	0	1	x	1
0	1	x	0	0
0	1	x	1	1
1	1	1	x	1
1	1	x	1	1
1	1	0	0	0

HEF4021 2A
8 bit SHIFT REGISTER



The HEF4021P is an edge-triggered 8-bit shift register (parallel-to-serial converter)with a synchronous serial data input (D) a clock input (CP), an asynchronous active HIGH parallel load input (PL), eight asynchronous parallel data inputs (P_0 to P_7) and buffered parallel outputs from the last three stages (Q_5 to Q_7). Information on P_0 to P_7 is asynchronously loaded into the register while PL is HIGH, independent of CP and D_S. Data present in the register is stored on the HIGH to LOW transition of PL. When PL is LOW, data on D is shifted into the first register position and all the data in the register is shifted one position to the right on the LOW to HIGH transition of CP.

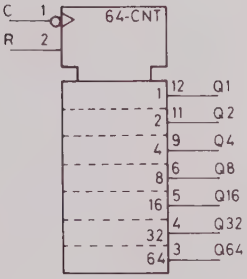
HEF4023 1A
Triple-3 input NAND



$Q = \overline{G1.G2.G3}$

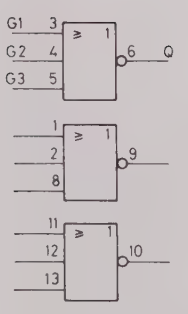
G1	G2	G3	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

HEF4024 1A
7 stage binary COUNTER



C = clock input (HIGH to LOW triggered)
R = master reset input
Q1 to Q64 = buffered parallel outputs.

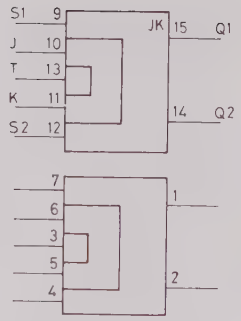
HEF4025 1A
Triple 3-input NOR



$Q = \overline{G1+G2+G3}$

See HEF4000

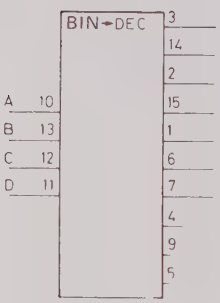
HEF4027 2A
Dual JK
FLIP-FLOP



S1	S2	T	J	K	Q1	Q2
1	0	x	x	x	1	0
0	1	x	x	x	0	1
1	1	x	x	x	1	1
0	0	⌐	0	0	No change	
0	0	⌐	1	0	1	0
0	0	⌐	0	1	0	1
0	0	⌐	1	1	Toggle	

T = clock input (Low to HIGH edge triggered)
S1= asynchronous set-direct input (active HIGH)
S2= asynchronous clear-direct input (active HIGH)

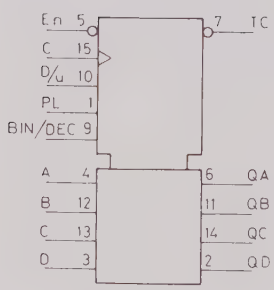
HEF4028 2A
1 of 10
DECODER



D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0							0
0	0	1	0	0	0	1	0						0
0	0	1	1	0		0	1	0					0
0	1	0	0	0			0	1	0				0
0	1	0	1	0				0	1	0			0
0	1	1	0	0					0	1	0		0
0	1	1	1	0						0	1	0	0
1	0	0	0	0							0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1
1	0	1	0	0	0	0	0	0	0	0	0	0	0
etc.				—INVALID—									
1	1	1	1	0	0	0	0	0	0	0	0	0	0

HEF4029 2A
Synchronous
UP/DOWN
COUNTER

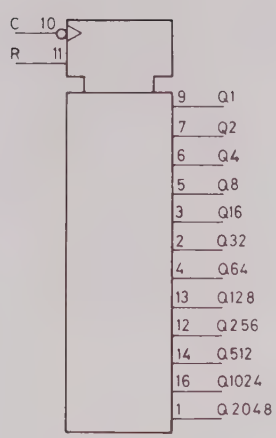
Binary/decade
COUNTER



The HEF4029 is a synchronous edge-triggered up/down 4-bit binary/BCD decade counter

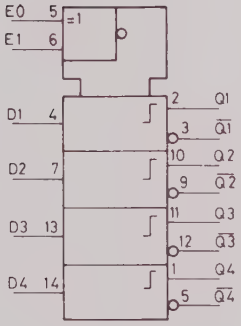
PL	Bin/Dec.	D/U	En	C	
1	x	x	x	x	Parallel load
0	x	x	1	x	No change
0	0	0	0	⌐	Count down, decade
0	0	1	0	⌐	Count up, decade
0	1	0	0	⌐	Count down, binary
0	1	1	0	⌐	Count up, binary

HEF4040 2A
12stage binary
COUNTER



Counter advances on a HIGH to LOW transition of C input.
R = 1 clears all counter stages and all outputs = 0 (independent of C input).

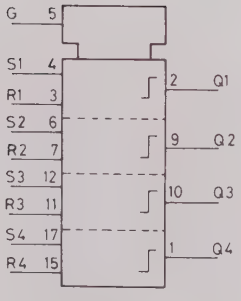
HEF4042 2A
Quad
D–LATCH



E0	E1	Latch condition
0	0	Enabled
0	1	Not enabled
1	0	Not enabled
1	1	Enabled.

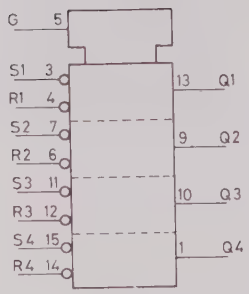
Data transfer from D to Q when enabled.

HEF4043 2A
Quad. R/S
LATCH
with 3 state
outputs



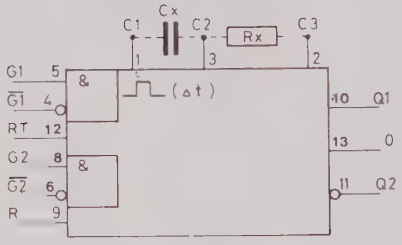
G	Sn	Rn	Qn (3 state)
0	x	x	High impedance
1	1	0	1
1	0	1	0
1	1	1	1
1	0	0	No change

HEF4044 2A
Quad. R/S
LATCH
with 3 state
outputs



G	Sn	Rn	Qn (3 state)
0	x	x	High impedance
1	0	1	1
1	1	0	0
1	0	0	0
1	1	1	No change

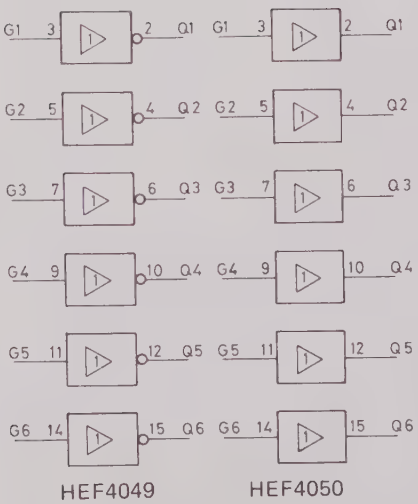
HEF4047 2A
Monostable/
Astable
MULTIVIBRATOR



G1 = enable inputs
G2 = trigger inputs (monostable mode)
R = master reset

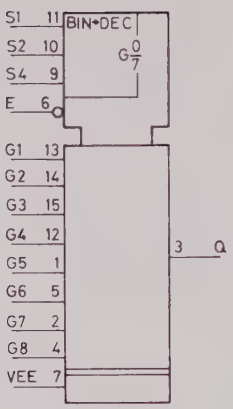
Monostable operation when G1 = 0 and $\overline{G1}$ = 1
Astable operation when G1 = 1 and $\overline{G1}$ = 0

HEF4049 2B
HEF4050
Hex-inverting/
non-inverting
BUFFERS



Q = $\overline{G}$ (HEF4049)
Q = G (HEF4050)

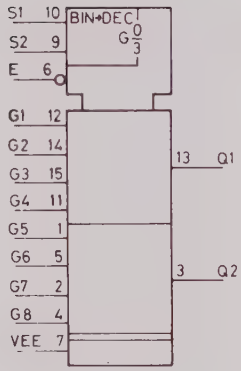
HEF4051 2A
8-channel analogue MULTIPLEXER DEMULTIPLEXER



E	S4	S2	S1	G1-Q G2-Q G3-Q G4-Q G5-Q G6-Q G7-Q G8-Q
0	0	0	0	on
0	0	0	1	on
0	0	1	0	on
0	0	1	1	on
0	1	0	0	on
0	1	0	1	on
0	1	1	0	All off on
0	1	1	1	on
1	x	x	x	All off

For operation as a digital multiplexer/demultiplexer connect pin 7 (V_{EE}) to pin 8(V_{SS}, typically ground)

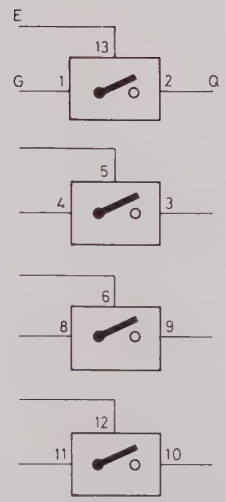
HEF4052 2A
Dual 4-channel analogue MULTIPLEXER/ DEMULTIPLEXER



E	S2	S1	G1-Q G2-Q G3-Q G4-Q
0	0	0	on
0	0	1	on
0	1	0	on
0	1	1	All off on
1	x	x	All off

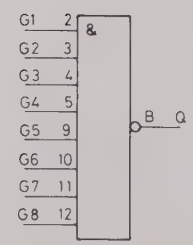
For operation as a digital multiplexer/demultiplexer connect pin 7 (V_{EE}) to pin 8 (V_{SS}, typically ground)

HEF4066 1A
Quad. bilateral SWITCHES



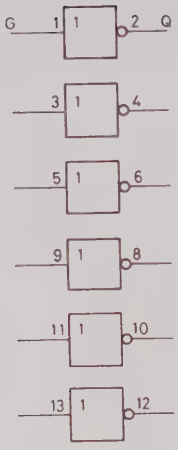
When E = 1, G to Q is low impedance (ON)
When E = 0, G to Q is high impedance (OFF)

HEF4068 1A
8-input NAND



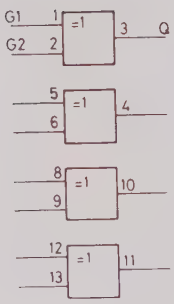
$Q = \overline{G1.G2.G3.G4.G5.G6.G7.G8}$ Q=0 when all G-inputs= 1, otherwise Q=1

HEF4069 1A
Hex.
INVERTER



$Q = \overline{G}$

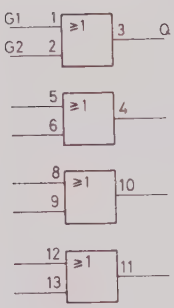
HEF4070 1A
Quad.
EXCL. OR



$Q = G1 \oplus G2 = \overline{G1}.G2 + G1.\overline{G2}$

G1	G2	Q
0	0	0
0	1	1
1	0	1
1	1	0

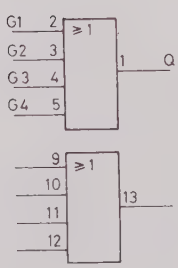
HEF4071 1A
Quad.2-input
OR



$Q = G1 + G2$

G1	G2	Q
0	0	0
0	1	1
1	0	1
1	1	1

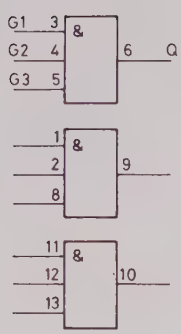
HEF4072 1A
Dual 4-input
OR



$Q = G1+G2+G3+G4$

Q = 1 unless all G inputs = 0

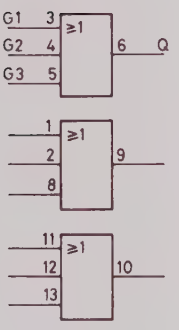
HEF4073 1A
Triple 3-input
AND



Q = G1.G2.G3

G1	G2	G3	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

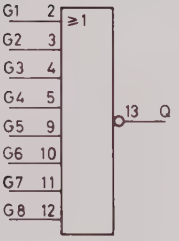
HEF4075 1A
Triple 3-input
OR



Q = G1+G2+G3

G1	G2	G3	Q
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

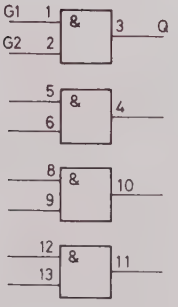
HEF4078 1A
8-input
NOR



$Q = \overline{G1+G2+G3+G4+G5+G6+G7+G8}$

Q = 0 unless all G inputs = 0

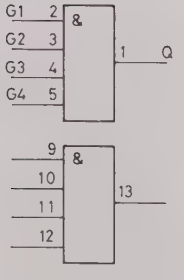
HEF4081 1A
Quad. 2-input
AND



Q = G1.G2

G1	G2	Q
0	0	0
0	1	0
1	0	0
1	1	1

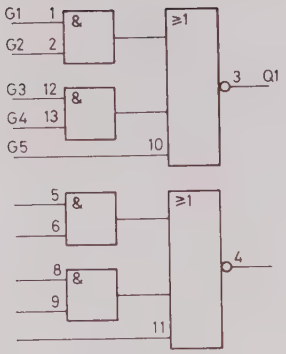
HEF4082 1A
Dual 4-input
AND



Q = G1+G2+G3+G4

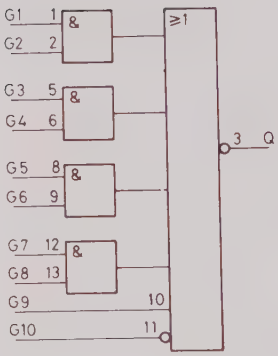
Q = 1 when all G inputs = 1
otherwise Q = 0

HEF4085 1A
Dual 2-wide
2-input
AND-OR-IN-
VERT GATE



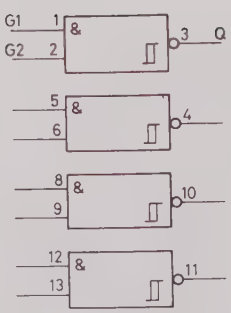
$Q1 = \overline{G1.G2 + G3.G4 + G5}$

HEF4086 1A
4-wide, 2-input
AND-OR-INVERT
GATE



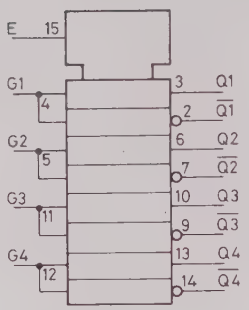
If G9 = 1 or G10 = 0 the output Q = 0 independent of inputs G1 to G8

HEF4093 1A
Quad. 2-input
NAND SCHMITT
TRIGGER



$\overline{Q} = \overline{G1.G2}$

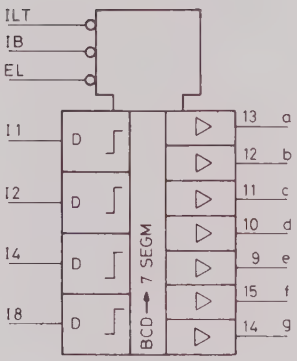
HEF4104 2C
Quad.low voltage to high voltage translator (3 state)



When E = 1, outputs are in the low impedance ON state, either HIGH or LOW as determined by G1 to G4. When E = 0, outputs are in the high impedance OFF state.

V_{SS} is a common negative supply
V_{DD1} is a positive supply for input circuits
V_{DD0} is a positive supply for ouput circuits.
$V_{DD1} \leqslant V_{DD0}$

HEF4511 2A
BCD to 7seg. LATCH/ DECODER/ DRIVER

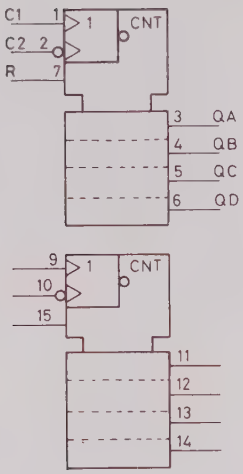


I_{LT}=lamp test input (active low)
I_B =ripple blanking input (active low)
EL =latch enable input(active low)
I1 to I8=address (data)inputs
a to g=segment outputs

EL	I_B	I_{LT}	A4	A3	A2	A1	a	b	c	d	e	f	g	Display
x	x	0	x	x	x	x	1	1	1	1	1	1	1	8
x	0	1	x	x	x	x	0	0	0	0	0	0	0	blank
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	blank
0	1	1	1	0	1	1	0	0	0	0	0	0	0	blank
0	1	1	1	1	0	0	0	0	0	0	0	0	0	blank
0	1	1	1	1	0	1	0	0	0	0	0	0	0	blank
0	1	1	1	1	1	0	0	0	0	0	0	0	0	blank
0	1	1	1	1	1	1	0	0	0	0	0	0	0	blank
1	1	1	x	x	x	x	1)							1)

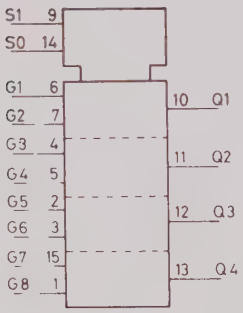
1) Depends on the BCD code applied during the LOW to HIGH transition of EL.

HEF4518 2A
Dual BCD
COUNTER



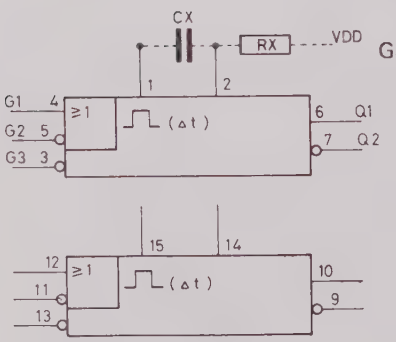
C1	C2	R	Mode
⌠	1	0	Counter advances
0	⌡	0	,, ,,
⌡	x	0	No change
x	⌠	0	,, ,,
⌠	0	0	,, ,,
1	⌡	0	,, ,,
x	x	1	QA–QD = 0

HEF4519 2A
Quad.
2-input
MULTIPLEXER



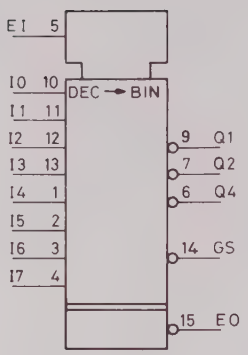
Select		Input		Output
S1	S0	G_{odd}	G_{even}	
0	0	x	x	0
1	0	G_{odd}	x	G_{odd}
0	1	x	G_{even}	G_{even}
1	1	0	0	1
1	1	1	0	0
1	1	0	1	0
1	1	1	1	1

HEF4528 2A
Dual retriggerable
resettable mono-
stable
MULTIVIBRATOR



G3 = clear direct output (active low).

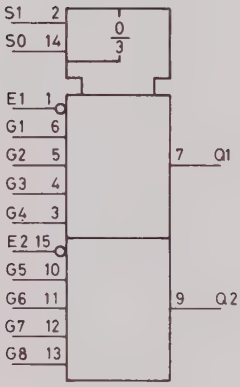
HEF4532 2A
8-input
priority
ENCODER



E_{in}	I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0	GS	Q4	Q2	Q1	E_{out}
0	x	x	x	x	x	x	x	x	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	1
1	1	x	x	x	x	x	x	x	1	1	1	1	0
1	0	1	x	x	x	x	x	x	1	1	1	0	0
1	0	0	1	x	x	x	x	x	1	1	0	1	0
1	0	0	0	1	x	x	x	x	1	1	0	0	0
1	0	0	0	0	1	x	x	x	1	0	1	1	0
1	0	0	0	0	0	1	x	x	1	0	1	0	0
1	0	0	0	0	0	0	1	x	1	0	0	1	0
1	0	0	0	0	0	0	0	1	1	0	0	0	0

GS = 1 when one or more priority inputs and EI = 1
EO = 1 when I_0 to I_7 all = 0 and EI = 1
EI = 0 forces all outputs low.

HEF4539 2A
Dual 4-input
MULTIPLEXER

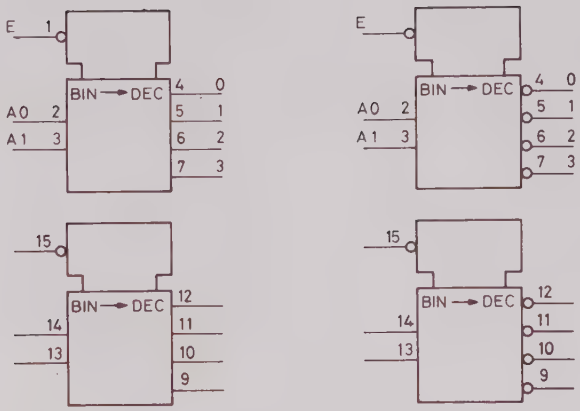


S0	S1	E1	Q
x	x	1	0
0	0	0	G1
1	0	0	G2
0	1	0	G3
1	1	0	G4

E2 = 1

E1 = 1 and E2 = 0 will select output from G5 to G8 input

HEF4555 2A
HEF4556
Dual 1 of 4
DECODER



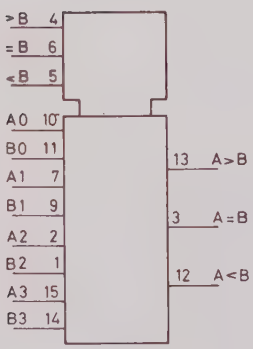
HEF4555

E	A0	A1	0	1	2	3
0	0	0	1	0	0	0
0	1	0	0	1	0	0
0	0	1	0	0	1	0
0	1	1	0	0	0	1
1	x	x	0	0	0	0

HEF4556

E	A0	A1	0	1	2	3
0	0	0	0	1	1	1
0	1	0	1	0	1	1
0	0	1	1	1	0	1
0	1	1	1	1	1	0
1	x	x	1	1	1	1

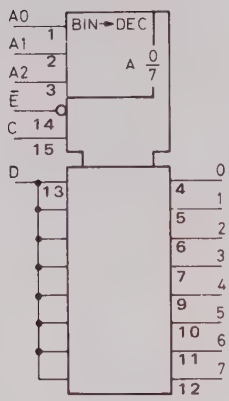
HEF4585 2A
4-bit
COMPARATOR



Comparing inputs				cascading inputs			outputs		
A_3, B_3	A_2, B_2	A_1, B_1	A_0, B_0	<B	=B	>B	A<B	A=B	A>B
$A_3>B_3$	X	X	X	X	X	H	L	L	H
$A_3=B_3$	$A_2>B_2$	X	X	X	X	H	L	L	H
$A_3=B_3$	$A_2=B_2$	$A_1>B_1$	X	X	X	H	L	L	H
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0>B_0$	X	X	H	L	L	H
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	L	L	H	L	L	H
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	L	H	L	L	H	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	H	L	L	H	L	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0<B_0$	X	X	X	H	L	L
$A_3=B_3$	$A_2=B_2$	$A_1<B_1$	X	X	X	X	H	L	L
$A_3=B_3$	$A_2<B_2$	X	X	X	X	X	H	L	L
$A_3<B_3$	X	X	X	X	X	X	H	L	L

The HEF4585B is a 4-bit magnitude comparator which compares two 4-bit words (A,B), each word having four parallel inputs (A_0 to A_3 and B_0 to B_3); A_3 and B_3 being the most significant inputs. Operation is not restricted to binary codes, the device will work with any monotonic code. Three outputs are provided: A greater than B (A> B), A less than B (A < B), A equal to B (A=B). Three expander inputs (>B, < B and =B), allow cascading without external gates. For proper compare operation the expander inputs to the least significant position must be connected as follows: < B = > B=LOW, =B=HIGH. For serial (ripple) expansion, the A > B, A < B and A=B outputs are connected respectively to the > B, < B and =B inputs of the next most significant comparator.

HEF4724 2A
8-bit
addressable
LATCH

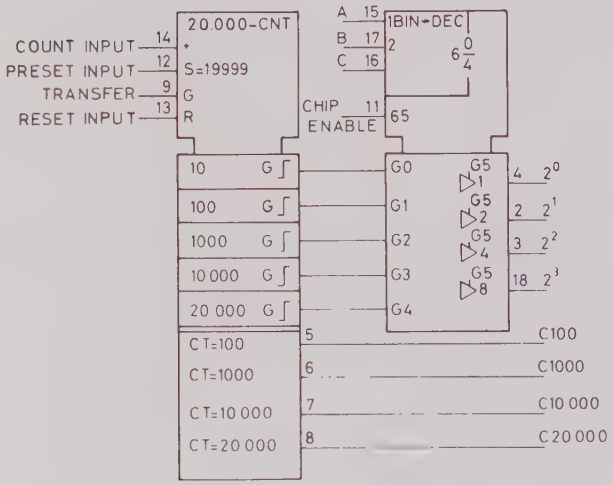


C	Ē	D	A_0	A_1	A_2	0	1	2	3	4	5	6	7	mode
1	1	x	x	x	x	0	0	0	0	0	0	0	0	clear
1	0	0	0	0	0	0	0	0	0	0	0	0	0	demultiplex
1	0	1	0	0	0	1	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	0	0	0	0	0	0	0	
1	0	1	1	0	0	0	1	0	0	0	0	0	0	
1	0	0	0	1	0	0	0	0	0	0	0	0	0	
1	0	1	0	1	0	0	0	1	0	0	0	0	0	
1	0	0	1	1	0	0	0	0	0	0	0	0	0	
1	0	1	1	1	0	0	0	0	1	0	0	0	0	
1	0	0	0	0	1	0	0	0	0	0	0	0	0	
1	0	1	0	0	1	0	0	0	0	1	0	0	0	
1	0	0	1	0	1	0	0	0	0	0	0	0	0	
1	0	1	1	0	1	0	0	0	0	0	1	0	0	
1	0	0	0	1	1	0	0	0	0	0	0	0	0	
1	0	1	0	1	1	0	0	0	0	0	0	1	0	
1	0	0	1	1	1	0	0	0	0	0	0	0	0	
1	0	1	1	1	1	0	0	0	0	0	0	0	1	
0	1	x	x	x	x	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	memory
0	0	0	0	0	0	L	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	addressable latch
0	0	1	0	0	0	H	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	0	1	0	0	0_n-1	L	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	1	1	0	0	0_n-1	H	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	0	0	1	0	0_n-1	0_n-1	L	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	1	0	1	0	0_n-1	0_n-1	H	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	0	1	1	0	0_n-1	0_n-1	0_n-1	L	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	1	1	1	0	0_n-1	0_n-1	0_n-1	H	0_n-1	0_n-1	0_n-1	0_n-1	
0	0	0	0	0	1	0_n-1	0_n-1	0_n-1	0_n-1	L	0_n-1	0_n-1	0_n-1	
0	0	1	0	0	1	0_n-1	0_n-1	0_n-1	0_n-1	H	0_n-1	0_n-1	0_n-1	
0	0	0	1	0	1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	L	0_n-1	0_n-1	
0	0	1	1	0	1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	H	0_n-1	0_n-1	
0	0	0	0	1	1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	L	0_n-1	
0	0	1	0	1	1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	H	0_n-1	
0	0	0	1	1	1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	L	
0	0	1	1	1	1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	0_n-1	H	

Note: 0_n-1 = state before the positive transition of E.

The HEF4724B is an 8-bit addressable latch with three address inputs (A_0 to A_2), a data input (D), an active LOW enable input ($\overline{E}$), an active HIGH clear input (C), and eight parallel latch outputs (0 to 7).
When $\overline{E}$ and C are HIGH, all outputs (0 to 7) are LOW.
Eight-channel demultiplexing or active HIGH 1-of-8 decoding with output enable operation occurs when C is HIGH and $\overline{E}$ is LOW.
When C and $\overline{E}$ are LOW, the selected output (0 to 7 ; determined by A_0 to A_2)follows D. When $\overline{E}$ goes HIGH, the contents of the latch are stored. When operating in the addressable latch mode ($\overline{E}$ = C = LOW), changing more than one bit of A_0 to A_2 could impose a transient wrong address. Therefore, this should only be done while in the memory mode ($\overline{E}$ = HIGH, C = LOW).

HEF4737 3A
Quad. static decade COUNTER



Output signals

Carry output C100

When the contents of the first two decades of the counter are both 9 then the C100 output becomes LOW. It remains LOW until the next LOW to HIGH transition of the count input, i.e. until the contents of the first two decades are zero. C100 is LOW when the contents of the counter are: 00099, 00199, 00299 etc.

Carry output C1000

When the contents of the first three decades of the counter are all 9 then the C1000 output becomes LOW. It remains LOW until the next LOW to HIGH transition of the count input, i.e. until the contents of the first three decades are zero. C1000 is LOW when the contents of the counter are: 00999, 01999, 02999 etc.

Carry output C10.000

When the contents of the first four decades of the counter are all 9 then the C10.000 output becomes LOW. It remains LOW until the next LOW to HIGH transition of the count input, i.e. until the contents of the first four decades are zero. C10.000 is LOW when the contents of the counter are 09999 and 19999.

The carry signals C100, C1000 and C10.000 are suppressed while the preset is active. A HIGH to preset input sets the counter to 19999 but the carry signals remain HIGH until preset input returns to LOW, when the carry inputs will also become LOW.

Carry output 20.000

When the contents of the counter is 10.000 the C20.000 output becomes LOW. It returns to HIGH when the contents of the counter is zero.

Digit outputs

The digit outputs give the contents of the selected latch. The output is in the form of BCD, positive logic.

Input signals

Count input

The signal to be counted is applied to this input. A LOW to HIGH transition at this input increments the contents of the counter by 1.

Reset input

This is an asynchronous reset. A HIGH level applied to this input will reset the counter to zero independent of the level at the count input.

Preset input

This is an asynchronous preset. A HIGH level applied to this input will preset the counter to 19999 independent of the level at the count input.

Transfer input

A HIGH level applied to this input allows the information held by the counter to pass to the latches.

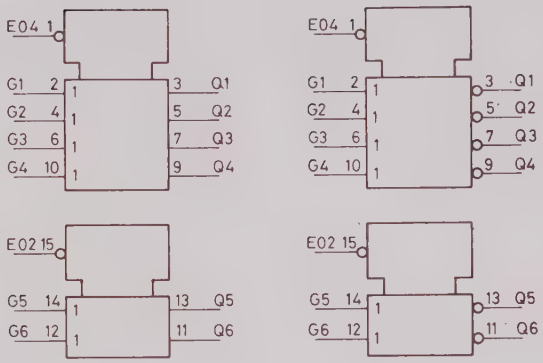
Chip enable input

A HIGH level at this input enables the BCD outputs and information can be read out of the latches using the multiplexer. A LOW level at this input disables the BCD outputs making them floating.

Digit select inputs; A, B and C

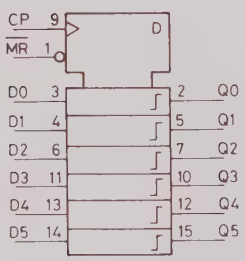
A	B	C	
0	0	0	selects G0 (LSD)
1	0	0	selects G1
0	1	0	selects G2
1	1	0	selects G3
X	X	1	selects G4 (MSD)

HEF40097 2A
HEF40098
3 state Hex
non-inverting/
inverting
BUFFER



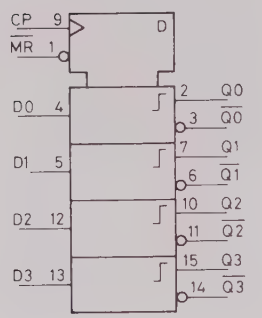
When EO 4 = 1, outputs Q1 to Q4 assume high impedance (off state)
When EO 2 = 1, „ Q5 and Q6 „ „ „ („)
When EO 4 = 0 enables outputs Q1 to Q4 (on state), and EO 2 = 0 enables Q5 and Q6.

HEF40174 2A
Hex. D type
FLIP-FLOP



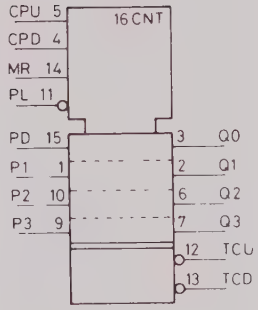
CP = Clock input
$\overline{MR}$ = master reset (asynchronous)
Information on D0 to D5 is transferred to Q0 to Q5 on the LOW to HIGH transition of CP, if $\overline{MR}$ is HIGH.
$\overline{MR}$ = 0 resets all flip-flops (outputs = 0)

HEF40175 2A
Quad. D type
FLIP-FLOP



CP = clock input
$\overline{MR}$ = master reset (asynchronous)
Information on D0 to D3 is transferred to Q0 to Q3 outputs on the LOW to HIGH transition of CP, if $\overline{MR}$ is HIGH. MR = 0 resets all flip-flops to zero.

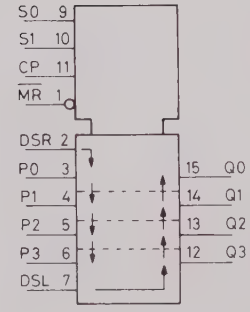
HEF40192 2A
HEF40193
4-bit up/down
decade/binary
COUNTER



HEF40192 is a BCD decade counter, and HEF40193 is a binary counter.
CPU = count-up clock input, CPD = count-down clock input
TCU = terminal count-up (carry) output,
TCD = terminal count-down (borrow) output).
MR = master reset (asynchronous)
PL = parallel load input (asynchronous)

MR	PL	CPU	CPD	MODE
1	x	x	x	Reset (asynchronous)
0	0	x	x	Preset (asynchronous)
0	1	1	1	No change
0	1	⌐	1	Count-up
0	1	1	⌐	Count-down.

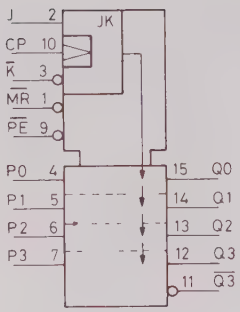
HEF40194 2A
4-bit
bidirectional
SHIFT
REGISTER



Mode	$\overline{MR}$	S1	S0	DSR	DSL	P0toP3	Q0	Q1	Q2	Q3
Hold	1	0	0	x	x	x	Q0	Q1	Q2	Q3
Shift left	1	1	0	x	0	x	Q1	Q2	Q3	0
	1	1	0	x	1	x	Q1	Q2	Q3	1
Shift right	1	0	1	0	x	x	0	Q0	Q1	Q2
	1	0	1	1	x	x	1	Q0	Q1	Q2
Parallel load	1	1	1	x	x	L	0	0	0	0
	1	1	1	x	x	H	1	1	1	1
Off	0	x	x	x	x	x	0	0	0	0

Output state shown after following LOW to HIGH transition of CP.

HEF40195 2A
4-bit
universal
SHIFT
REGISTER

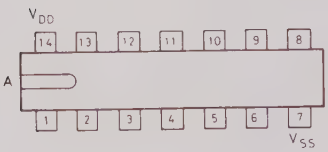


Mode	MR	PE	J	K	P0	P1	P2	P3	Q0	Q1	Q2	Q3	Q3
Shift	1	1	0	0	x	x	x	x	0	Q1	Q1	Q2	Q2
	1	1	0	1	x	x	x	x	Q0	Q0	Q1	Q2	Q2
	1	1	1	0	x	x	x	x	Q0	Q0	Q1	Q2	Q2
	1	1	1	1	x	x	x	x	1	Q0	Q1	Q2	Q2
Parallel entry	1	0	x	x	0	0	0	0	0	0	0	0	1
	1	0	x	x	1	1	1	1	1	1	1	1	0
Off	0	x	x	x	x	x	x	x	0	0	0	0	1

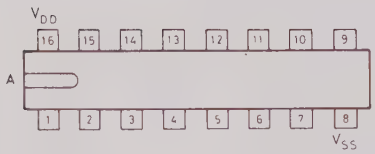
Output state shown after following LOW to HIGH transition of CP.

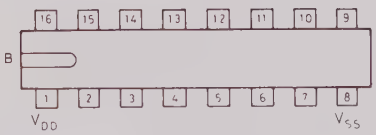
Package outline (Viewed from above - component side)

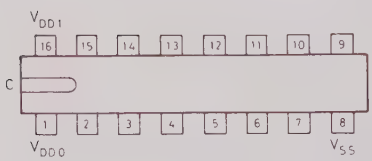
1



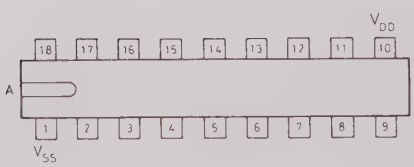
2







3



Voltages

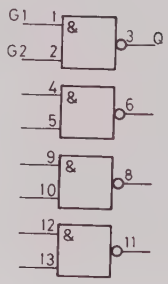
In the LOCMOS specifications, all voltages are referenced to V_{SS}, which is the most negative potential applied to the device.

V_{DD}: Drain voltage; the most positivie potential on the device

Vss : Source voltage; for a device with a single power supply, the most negative power supply, used as a reference level for other voltages.
Typically ground.

TTL Integrated circuits

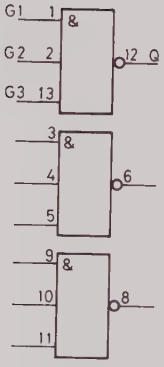
N74LS00
Quad, 2-input
NAND



$Q = \overline{G1.G2}$

G1	G2	Q
0	0	1
0	1	1
1	0	1
1	1	0

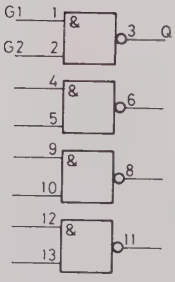
N74LS10
Triple, 3-input
NAND



$Q = \overline{G1.G2.G3}$

G1	G2	G3	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

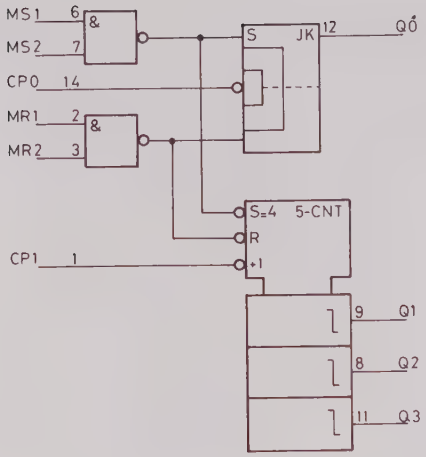
N74LS26
Quad, 2-input
NAND
(open collector)



$\overline{Q = G1.G2}$

G1	G2	Q
0	0	1
0	1	1
1	0	1
1	1	0

N74LS90
Decade counter



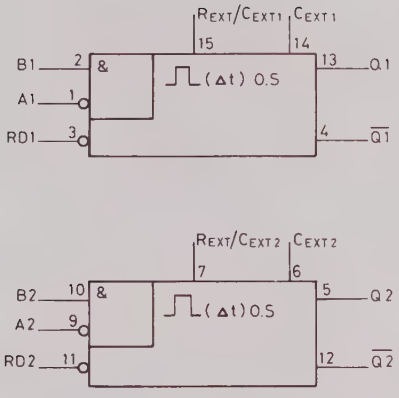
MODE SELECTION

MR1	MR2	MS1	MS2	Q0	Q1	Q2	Q3
1	1	0	x	0	0	0	0
1	1	x	0	0	0	0	0
x	x	1	1	1	0	0	1
0	x	0	x		Count		
x	0	x	0		Count		
0	x	x	0		Count		
x	0	0	x		Count		

BCD COUNT SEQUENCE

COUNT	Q3	Q2	Q1	Q0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

74LS123
Dual Retriggerable
Monostable Multivibrator

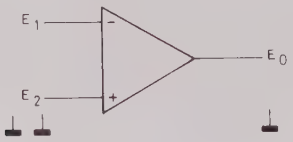


RD	A	B	Q	$\bar{Q}$
0	x	x	0	1
0	1	x	0	1
x	x	0	0	1
1	0	↑	⎍	⎎
1	↓	1	⎍	⎎
↑	0	1	⎍	⎎

Linear Integrated Circuits.

Operational Amplifier (Op. Amp.)

Symbol:



E_1, E_2 and E_0 are voltages of inputs and output with respect to zero volt. (earth)

The operational amplifier is a dc-coupled amplfiier with (one single input or) a differential input (as symbol). This means that one of the two differential inputs is shifted 180° in phase during the amplification.

For a rough approximation of circuit calculations with operational amplifiers the amplifier is shown as ideal. The idealised "values" are then:

- the open-loop gain A_0 (without feed back) is infinity (∞)
- output voltage $E_0 = 0$, if input voltage $E_1 = E_2$ (no offset)
- input $\frac{\text{resistance}}{\text{impedance}}$ is infinity (∞)
- output $\frac{\text{resistance}}{\text{impedance}}$ is zero (0)
- frequency band is infinity (GAIN is constant for all frequencies)

In an ideal situation $E_0 = A_0 (E_2 - E_1)$. In practice, however, one has to take into account the characteristics of the operational amplifier.
For the technical specifications refer to the performance figures for the integrated circuit.

Some definitions:

- *Operating ambient temperature range:* ambient temperature range over which the amplifier works to its specifications.
- *Large signal voltage gain:* ratio of the maximum output voltage swing with load to the change in input voltage required to drive the output from zero to this voltage
- *Input offset voltage:* voltage which must be applied between the input terminals to obtain zero output voltage. (Some integrated circuits have separate pins for adjusting the offset voltage).
- *Input offset current:* difference in currents into the two input terminals with the output at zero volts.
- *Input bias current:* average of currents into the two input terminals with the output at zero volts.
- *Differential input resistance:* resistance at either input terminal with the other terminal grounded.
- *Common-mode input voltage range:* range of voltage on either input terminal which, if exceeded, can cause amplifier malfunction.
- *Differential-mode input voltage range:* range of voltage between input terminals which, if exceeded, can cause amplifier malfunction.
- *Output resistance:* Small signal device resitance between output terminal and earth.
- *Peak output voltage swing:* maximum amplitude of output voltage, at specified load, that can be obtained without clipping.

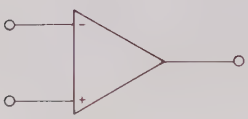
– *Power consumption:* the dc power taken by the amplifier at zero output voltage and current.

– *Common-mode rejection ratio:* ratio of input voltage range to the maximum change in input offset voltage over this range.

– *Supply voltage rejection ratio:* ratio of the change in input offset voltage to the change in supply voltage producing it.

– *Transient response:* closed-loop step function response of the amplifier under small-signal condition.

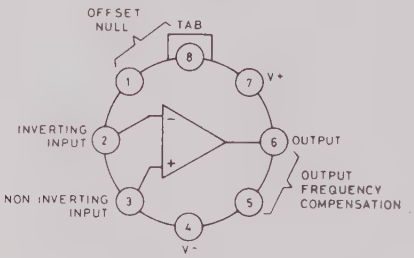
SSS725
(μA 725C)



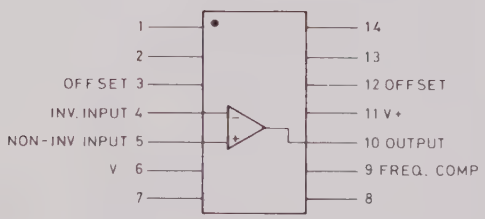
INSTRUMENTATION
OPERATIONAL AMPLIFIER

$V_{cc}+$: 1,5 to 22 V
$V_{cc}-$: 1,5 to – 22 V

(TOP VIEW)

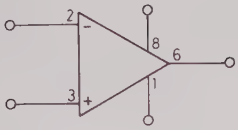


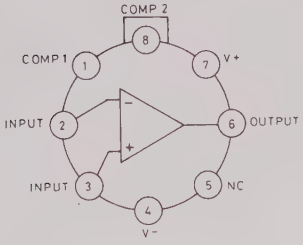
TO-99 (J-Suffix)
Type: SSS725 - 111J



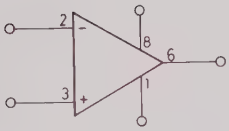
14 PIN CERAMIC DIP (Y)
Type: SSS725 - 111Y

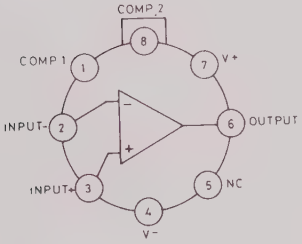
LM208T
Precision operational
Amplifier



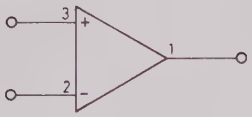


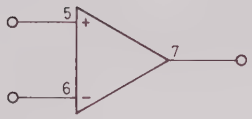
LM308T
Precision
operational amplifier



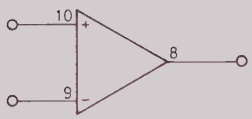


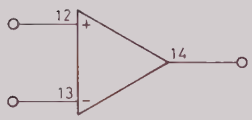
LM324N
LM324AF
LM324AN

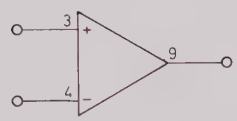




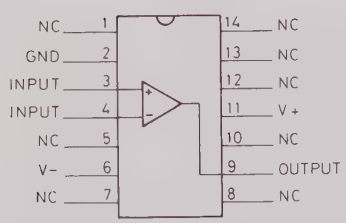
Quad general
purpose operational
amplifier

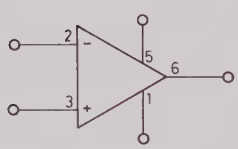




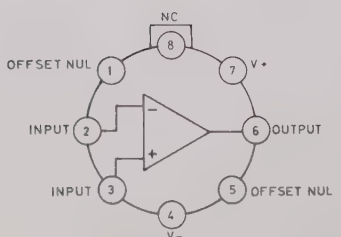


μA710CA
Differential
voltage comparator

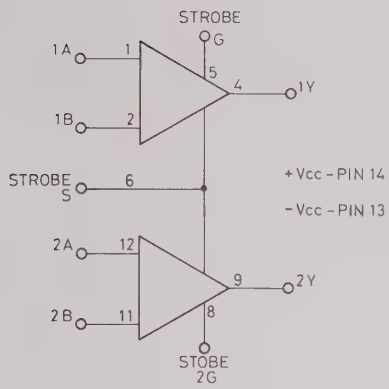




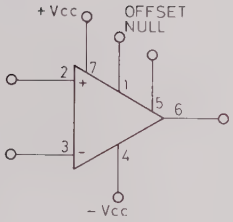
μA741T
General purpose
operational amplifier



NE521
High speed dual
differential comparator
sense amplifier

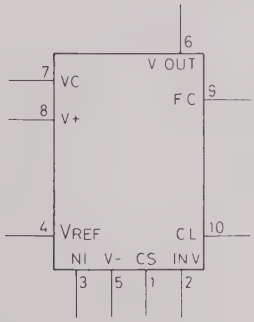


NE536
FET input
operational
amplifier



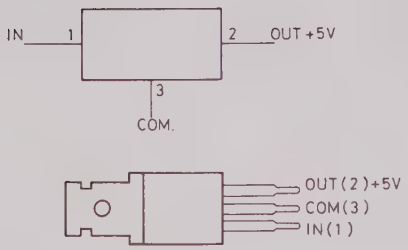
MISCELLANEOUS INTEGRATED CIRCUITS

μA723CL
Precision voltage
regulator

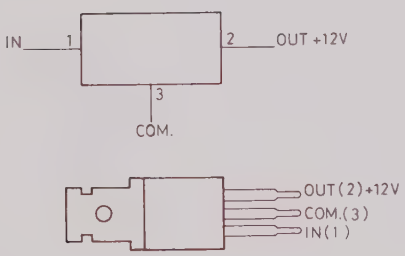


7805 CU

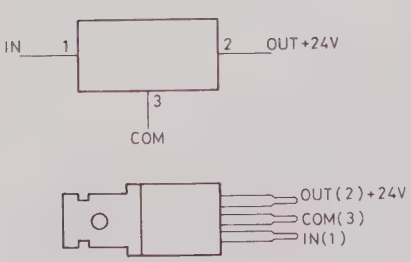
Three-terminal positive voltage regulator +5 volts



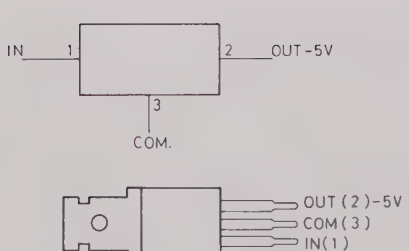
7812CU
Three-terminal positive voltage regulator + 12 volts



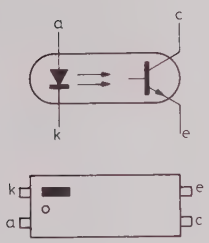
7824CU
Three-terminal positive voltage regulator +24 volts



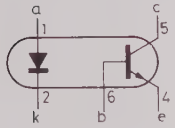
7905CU
Three-terminal negative voltage regulator —5 volts



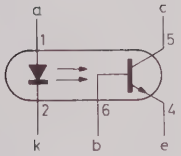
CNY42
Optocoupler



CNY47AP
Optocoupler

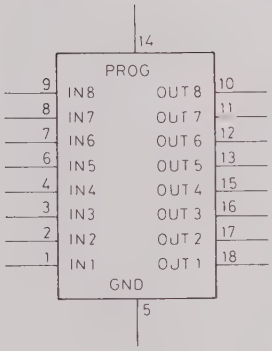


CNY57A
Optocoupler

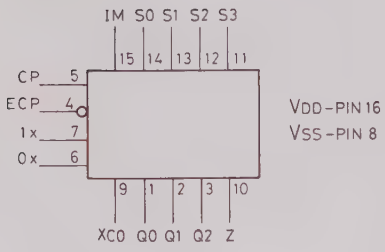


DI-210
Gas discharge display segment driver and level converter.

LOCMOS to 115 V



F4702PC
Programmable Bit Rate
Generator



S3	S2	S1	S0	Output rate (Z)
0	0	0	0	Multiplexed input (I_m)
0	0	0	1	Multiplexed input (I_m)
0	0	1	0	50 baud
0	0	1	1	75 baud
0	1	0	0	134,5 baud
0	1	0	1	200 baud
0	1	1	0	600 baud
0	1	1	1	2400 baud
1	0	0	0	9600 baud
1	0	0	1	4800 baud
1	0	1	0	1800 baud
1	0	1	1	1200 baud
1	1	0	0	2400 baud
1	1	0	1	300 baud
1	1	1	0	150 baud
1	1	1	1	110 baud

I_x	E_{cp}	CP	Mode of operation
⎍⎍⎍	1	0	Clocked from 1x
x	0	⎍⎍⎍	Clocked from CP
x	1	1	Continuous reset
x	0	⎍⎍	Reset during first CP = HIGH Time

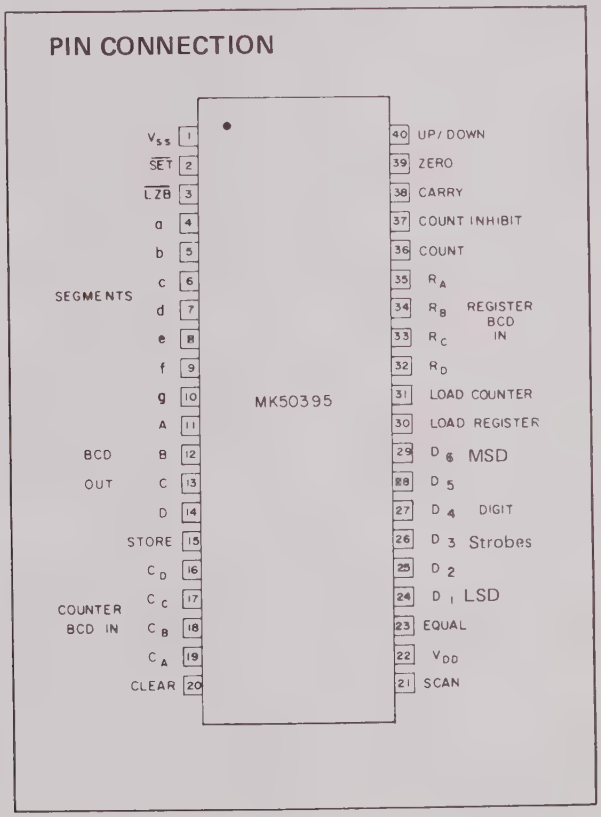
NOTE

Actual output frequency is 16 times the indicated output rate, assuming a clock frequency of 2,4576 MHz

MK50395N Counter/comparator (MOSTEK),

The MK50395 is an ion-implanted, P-channel MOSsix-decade synchronous up/down-counter/display driver with compare-register and storage-latches.
The counter as well as the register can be loaded digit-by-digit with BCD data. The counter has an asynchronous clear function.

Scanning is controlled by the scan oscillator input which is self-oscillating or can be overdriven by an external signal. The six-decade-register is constantly compared to the state of the six-decade-counter and when both the register and the counter have the same content, an EQUAL signal is generated. The contents of the counter can be transferred into the 6-digit latch which is then multiplexed from MSD to LSD in BCD and 7-segment format to the output. The seven-segment decoder incorporates a leading zero blanking circuit which can be disabled by an external signal. This device is indended to interface directly with the standard CMOS logic families.



Operations

Six decade counter, latch

The six decade counter is synchronously incremented or decremented on the positive edge of the count input signal. A Schmitt trigger on this input provides hysteresis for protection against both a noisy environment and double triggering due to a slow rising edge at the count input.

The count inhibit can be changed in coincidence with the positive transition of the count input; the count input is inhibited when the count inhibit is high.

The counter will increment when up/down input is high (V_{SS}) and will decrement when up/down input is low. The up/down input can be changed 75 μs prior to the positive transition of the count input.

The clear input is asynchronous and will reset all decades to zero when brought high but does not affect the six-digit latch or the scan counter.

As long as store input is low, data is continuously transferred from the counter to the display. Data in the counter will be latched and displayed when store input is high. Store can be changed in coincidence with the positive transition of the count input.

The counter is loaded with BCD data, digt-by-digit corresponding to the digit strobe outputs. BCD thumbweel switches with four diodes per decade connected between the digit strobe outputs and the BCD inputs will load the counter when the load counter input is taken high.
Counter input is inhibited while the load counter input is high. The load counter input must remain high a minimum of six digit strobe output periods.

Three basic outputs originate from the counter: zero output, equal output, and carry output. Each output goes high on the positive (V_{SS}) going edge of the following conditions:

- Zero output goes high for one count period when all decades contain zero. During a load counter operation the zero output is inhibited.
- Equal output goes high for one count period when the contents of the counter and compare register are equal. The equal output is inhibited by a load counter or load register operation.
- The carry output goes high with the leading edge of the count input at the count of 000000 when counting up or at 999999 when counting down and goes low with the negative going edge of the same count inpulse.

A count frequency of 1MHz can be achieved if the equal output, zero output and carry output are not used. These outputs do not respond at this frequency due to their output delay illustrated on the timing diagram.

Six decade compare register

The register is loaded with BCD data digit-by-digit corresponding to the digit strobe outputs. BCD thumbwheel switches with four diodes per decade connected between the digit strobe outputs and the BCD inputs will load the register when the load register input is taken high. The load register input must remain high a minimum of six digit strobe output periods.

This register is a static register and will not be cleared by the clear input.

BCD & Seven segment output

BCD or seven segment outputs are available. Digit strobes are decoded internally by a divide by six Johnson counter. This counter scans from MSD to LSD. By bringing the SET input low, this counter will be forced to the MSD decade count. During this time the segment outputs are blanked to protect against display burn out.

Both the segment outputs and digit strobes are blanked during the interdigit blanking time. Leading zero blanking affects only the segment outputs. This option is disabled by bringing the LZB input high.

BCD output data changes at the beginning of the interdigit blanking time. These outputs are CMOS compatible.

Scan oscillator

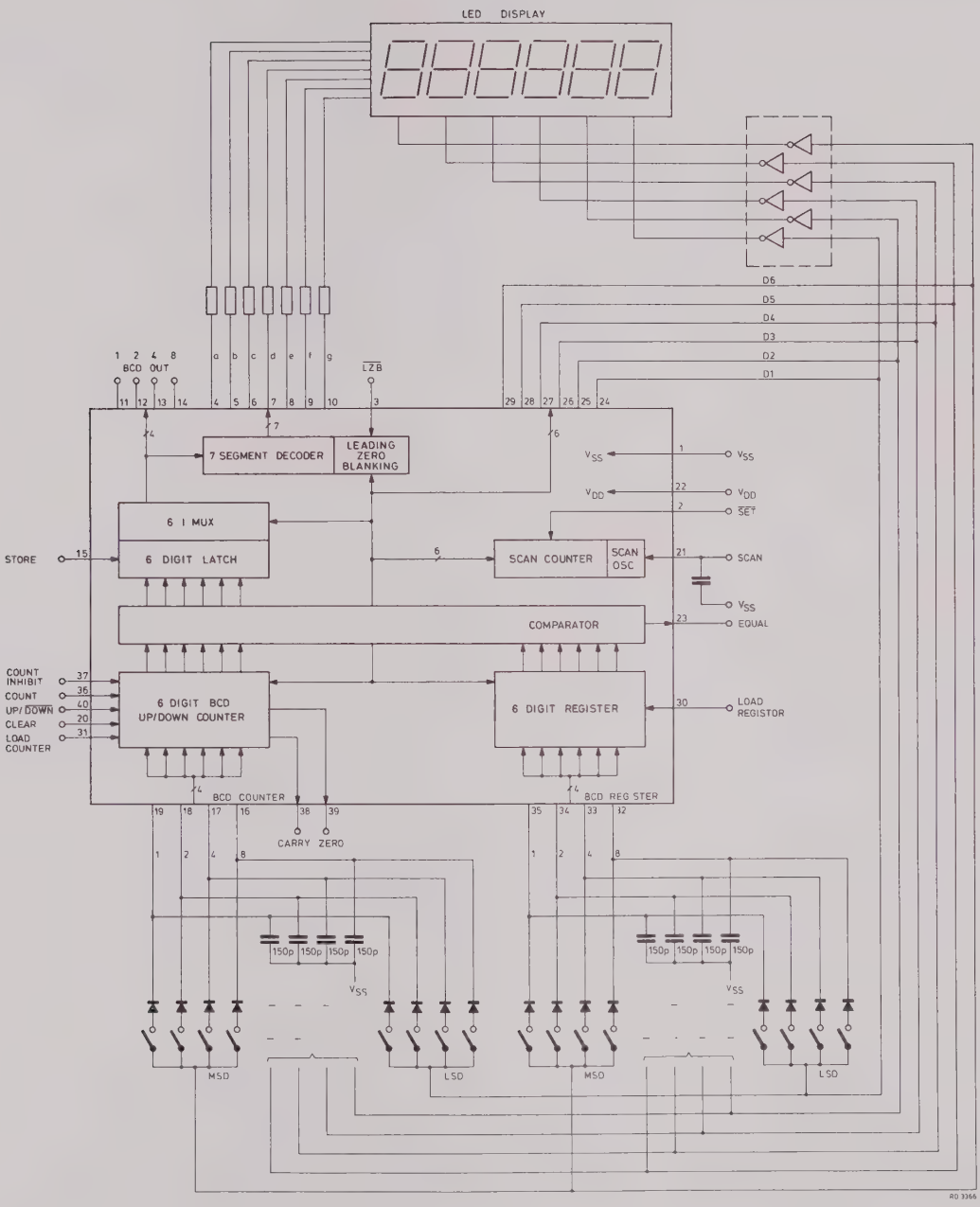
The MK50395 has an internal oscillator. The frequency of the scan oscillator is determined by an external capacitor between V_{SS} and scan input. The wave form present on the scan oscillator input is trianular.

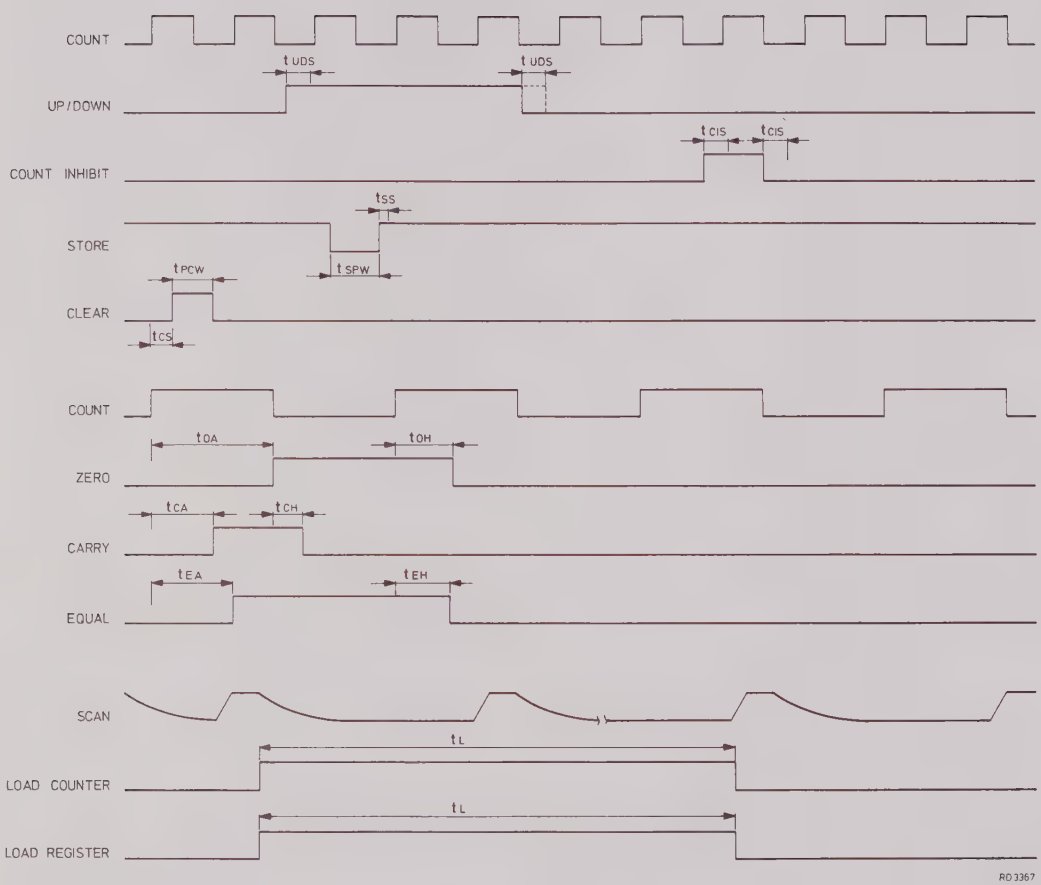
An external scan oscillator may also be used to drive the scan input. In either case, external capacitors of 150 pF each will be required from V_{SS} to Counter BCD input and register BCD input. This will allow asynchronous loading of the BCD inputs.

If external capacitors on the BCD inputs are undesirable, it will be necessary to synchronize the negative going edge of the load register and/or load counter command to coincide with the positive going edge of the scan input signal. Also the V_{SS} range should be limited from 10.8 to 13.2 volts.

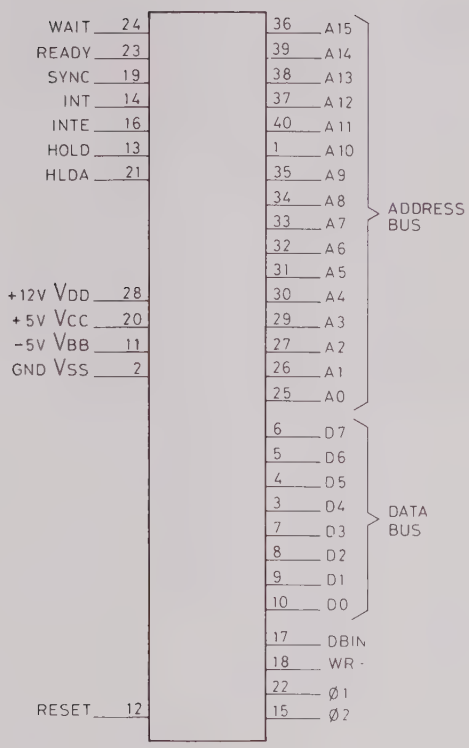
Typically, the scan oscillator will oscillate at the following frequencies with these nominal capacitor values from V_{SS} to scan input.

	Min	Max
820 pF	1.4 kHz	4.8 kHz
470 pF	2.0 kHz	6.8 kHz
120 pF	7.0 kHz	20 kHz.


LED DISPLAY
1 2 4 8
BCD OUT
a b c d e f g
LZB
D6
D5
D4
D3
D2
D1
7 SEGMENT DECODER
LEADING ZERO BLANKING
6 I MUX
6 DIGIT LATCH
STORE
SCAN COUNTER
SCAN OSC
SCAN
COMPARATOR
EQUAL
COUNT INHIBIT
COUNT
UP/DOWN
CLEAR
LOAD COUNTER
6 DIGIT BCD UP/DOWN COUNTER
6 DIGIT REGISTER
LOAD REGISTOR
BCD COUNTER
BCD REG STER
CARRY
ZERO
150p
MSD
LSD
RD 3366


COUNT
tUDS
tUDS
UP/DOWN
tCIS
tCIS
COUNT INHIBIT
tSS
STORE
tPCW
tSPW
CLEAR
tCS
COUNT
tOA
tOH
ZERO
tCA
tCH
CARRY
tEA
tEH
EQUAL
SCAN
tL
LOAD COUNTER
tL
LOAD REGISTER
RD3367

MP8080A
8-bit N-channel
MICROPROCESSOR



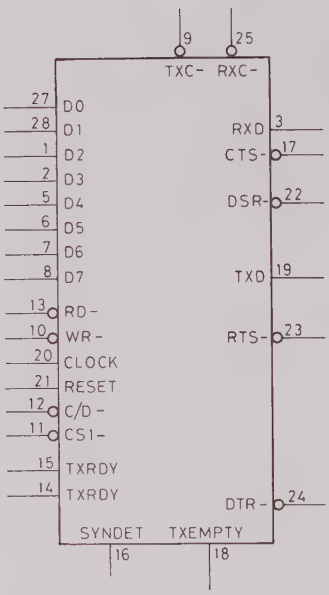
PIN DESIGNATION

Mnemonic	Pin no.	Type	Name and function
READY	23	I	**Ready:** When high (logic 1), indicates that valid memory or input data are available to the CPU on the MP8080A data bus. The Ready signal is used to synchronize the CPU with slower memory or input/output devices. If the MP8080A does not receive a high Ready input after sending out an address to memory or an input/output device, the MP8080A enters a Wait mode for as long as the Ready input remains low (logic 0). The CPU may also be single stepped by the use of the Ready signal.
HOLD	13	I	**Hold:** When high, requests that the CPU enter the Hold mode. When the CPU is in the Hold mode, the CPU address and the data buses both will be in the high-impedance state. The Hold mode allows an external device to gain control of the MP8080A address and data buses immediately following the completion of the current machine cycle by the CPU. The CPU acknowledges the Hold mode via the HLDA output line. The Hold request is recognized under the following conditions: 1. The CPU is in the Halt mode. 2. The Ready signal is active and the CPU is in the t_2 or t_w state.
INT	14	I	**Interrupt Request:** When high, the CPU recognizes an interrupt request on this line after completing the current instruction or while in the Halt mode. An interrupt request is not honored if the CPU is in the Hold mode (HLDA = logic 1) or the INTE Flip-flop is reset (logic 0).
RESET	12	I	**Reset:** When activated (high) for a minimum of three clock periods, the content of the Program Counter is cleared and the Interrupt Enable and HLDA Flip-flops are reset. Following a Reset, program execution starts at memory location 0. It should be noted that the status flags, accumulator, stack pointer, and registers are not cleared during the Reset sequence.
$\emptyset_1$ $\emptyset_2$	22,15	I	**$\emptyset_1$ and $\emptyset_2$ Clocks:** Two non-TTL compatible clock phases which provide nonoverlapping time references for internal storage elements and logic circuits of the CPU.
SYNC	19	O	**Synchronizing Signal:** When activated (high), the beginning of a new machine cycle is indicated and the status word is outputted on the Data Bus.
A_{15} - A_0	1,25-27	O	**Address Bus:** This bus comprises sixteen tri-state output lines. The bus provides the address to memory (up to 65k bytes) or denotes the input/output device number for up to 256 input and 256 output peripherals.
WAIT	24	O	**Wait:** When high, acknowledges that the CPU is in the Wait mode.
WR	18	O	**Write:** When low, the data on the data bus are stable for Write memory or output operation.
HLDA	21	O	**Hold Acknowledge:** Goes high in response to a logic 1 on the Hold line and indicates that the data and address bus will go to the high-impedance state. The HLDA begins at one of the following times: 1. The t_3 state of the Read memory input operation. 2. The clock period following the t_3 state of a Write memory output operation. In both cases, the HLDA signal starts after the rising edge of the $\emptyset_1$ clock, and high impedance occurs after the rising edge of the $\emptyset_2$ clock.

PIN DESIGNATION

Mnemonic	Pin no.	Type	Name and function
INTE	16	O	**Interrupt Enable:** Indicates the content of the internal INTE Flip-flop. The Enable and Disable Interrupt (EI and DI) Instructions cause the INTE Flip-flop to be set and reset, respectively. When the Flip-flop is reset (INTE = logic 0), it inhibits interrupts from being accepted by the CPU. In addition, the INTE Flip-flop is automatically reset (thereby disabling further interrupts) at the t_1 state of the instruction fetch cycle, when an interrupt is accepted; it is also reset by the Reset Signal.
D_7-D_0	3-10	I/O	**Data Bus:** This bus comprises eight tri-state input/output lines. The bus provides bidirectional communication between the CPU, memory, and input/output devices for instructions and data transfers. A status word (which describes the current machine cycle) is also outputted on the data bus during the first state of each machine cycle (SYNC = logic 1).
+12 V	28	I	**+12 Volts :** V_{DD} Supply.
+ 5 V	20	I	**+5 Volts:** V_{CC} Supply.
–5 V	11	I	**–5 Volts:** V_{BB} Supply.
GND	2	I	**Ground:** V_{SS} (0 volt) reference.

MP8251
Universal
Synchronous/Asynchronous
receiver/transmitter
(USART)

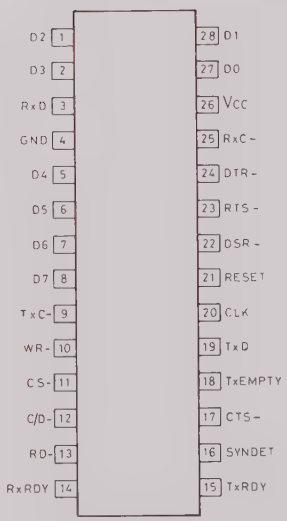


DESCRIPTION

The MP8251 is a programmable Universal Synchronous/Asynchronous Receiver/Transmitter (USART) chip contained in a standard 28-pin dual-in-line package. The chip, which is fabricated using N-channel silicon gate technology, functions as a serial data input/output interface in the MP8080A microcomputer family. The functional configuration of the MP8251 is programmed by the system software for maximum flexibility, thereby allowing the system to receive and transmit virtually any serial data communication signal presently in use.

The MP8251 can be programmed to receive and transmit either synchronous or asynchronous serial data. The MP8251 performs serial-to-parallel conversion on data characters received from the CPU. The CPU can read the complete status of the MP8251 at any time during the functional operation. Status information reported includes the type and the condition of the transfer operations being performed by the MP8251, as well as any transmission error conditions (parity, overrun, or framing).

IQ Package



PIN DESIGNATION MP 8251 (count)

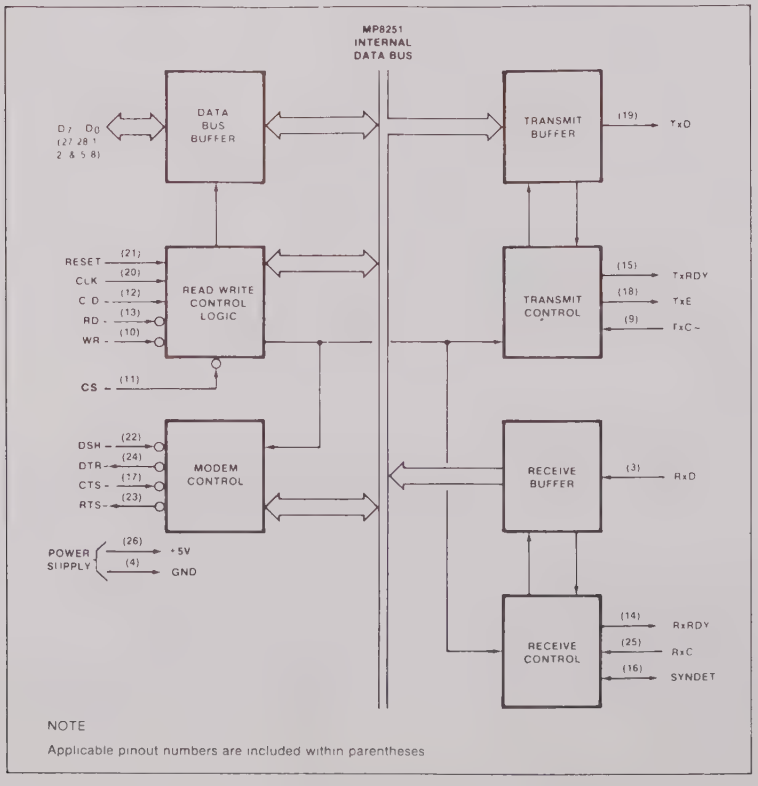
Mnemonic	Type	Name and function
CS–	I	**Chip select:** When low (logic 0), the chip is selected. This enables communication between the MP8251 and the MP8080A microprocessor.
RD–	I	**Read:** When low, allows the MP8080A to read data or status information from the MP8251.
WR–	I	**Write:** When low, allows the MP8080A to write data or control words into the MP8251.
C/D–	I	**Control/data:** Used in conjunction with an active RD or WR input (logic 0) to determine overall device operation as indicated below.
RESET	I	**Reset:** When high (logic 1), places the MP8251 in the idle mode. The device remains in this mode until a new set of control words is written into the MP8251 to program its functional definition. Minimum Reset pulse width is 6_{CY}.
CLK	I	**Clock:** TTL clock that is used to generate internal timing signals for the MP8251. The minimum frequency of the CLK input is 30 times the receiver/transmitter clock frequency for the synchronous mode, and 4.5 times the receiver/transmitter clock frequency for the asynchronous mode. The CLK input is normally connected to the ϕ_2 (TTL) output of the 8224 Clock Generator and Driver device.
DSR–	I	**Data set ready:** General purpose input whose condition can be tested by the MP8080A using a status read operation. However, a low level DSR input is normally used to test data set ready conditions.
CTS–	I	**Clear to send:** If low when the TxEn bit (D_0) of the command instruction Control Word (see figure) is set high, enables the MP8251 to transmit serial data.
TxC–	I	**Transmitter Clock:** This clock input controls the rate at which a data character is to be transmitted. The frequency of the TxC input is equal to the baud rate for the synchronous mode, and is a multiple (1x, 16x or 64x) of the baud rate for the asynchronous mode. A portion of the Mode Instruction Word (see figure) selects the value of the baud rate factor when in the asynchronous mode. Transmitter data are clocked out of the MP8251 on the falling edge of the TxC input.
RxD	I	**Receiver data:** Serial data input from a MODEM or an input/output device.
RxC–	I	**Receiver clock:** This clock input controls the rate at which a data character is to be received. The frequency and selection of the RxC input is as described above for the TxC input. Receiver data are clocked into the MP8251 on the rising edge of the RxC input.
V_{CC}		+5 V power supply.
GND		**Ground:** 0–V reference.
DTR–	O	**Data terminal ready:** General purpose output which can be set to an active low by programming the DTR bit (D_1) of the Command Instruction Control Word. However, a low level DTR output is normally used for data terminal ready or rate select control.
RTS–	O	**Request to send:** General purpose output which can be set to an active low by programming the RTS bit (D_5) of the Command Instruction Control Word. However, the RTS output is normally used for request to send control in the transmit mode.
TxD	O	**Transmitter data:** Composite serial data output to a MODEM or input/output device. The TxD output is held in the marking state (logic 1) upon a Reset operation.

CS–	C/D–	RD–	WR–	Operation
0	0	0	1	Data character read from MP8251
0	0	1	0	Data character written into MP8251
0	1	0	1	Status information read from MP8251
0	1	1	0	Control word written into MP8251
1	x	x	x	Device not selected

PIN DESIGNATION

Mnemonic	Type	Name and function
TxRDY	O	**Transmitter ready:** When high, alerts the MP8080A that the transmitter is ready to accept a data character. The TxRDY output, which is automatically reset whenever a character is written into the MP8251, can be used as an interrupt to the system. For polled operation, the condition of the TxRDY signal can be tested by the MP8080A using a status read operation.
TxE	O	**Transmitter empty:** Goes high to indicate the end of a transmit mode. The TxE output is automatically reset whenever a character is written into the MP8251. In the synchronous mode, a high-level TxE output indicates that a character has not been loaded, the transmitter buffer is empty, and the sync character(s) of a data block are soon to be transmitted automatically as fillers.
RxRDY	O	**Receiver ready:** When high, alert the MP8080A that the receiver contains a data character that is ready to be input to the CPU. The RxRDY output, which is automatically reset whenever a character is read from the MP8251, can be used as an interrupt to the system. For polled operation, the condition of the RxRDY signal can be tested by the MP8080A using a status read operation.
D_7-D_0	I/O	**Data bus:** This bus comprises eight Tri-state input/output lines. The bus provides bidirectional communications between the MP8251 and the MP8080A. Data are routed to or from the internal data bus buffer upon execution of an MP8080A OUT or IN instruction, respectively. In addition, control words, command words and status information are transferred through the data bus buffer.
SYNDET	I/O	**Sync detect:** This pin may be used in the synchronous mode only. System software can program SYNDET as either an input or an output. When used as an output (Internal sync detect mode), a high level SYNDET output is automatically reset upon a status read operation by the MP8080A. When used as an input (external sync detect mode) a high level SYNDET causes the MP8251 to start assembling data characters on the falling edge of the next RxC input.

BLOCK DIAGRAM

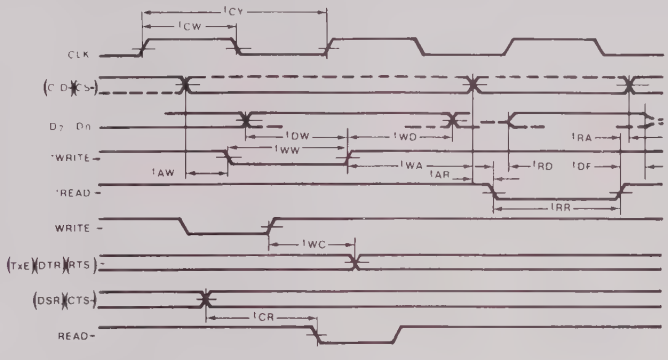


NOTE

Applicable pinout numbers are included within parentheses

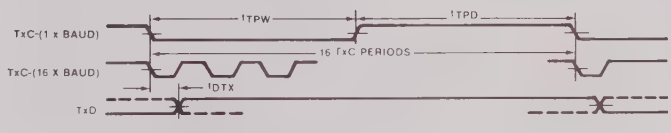
TIMING WAVEFORMS

READ AND WRITE TIMING

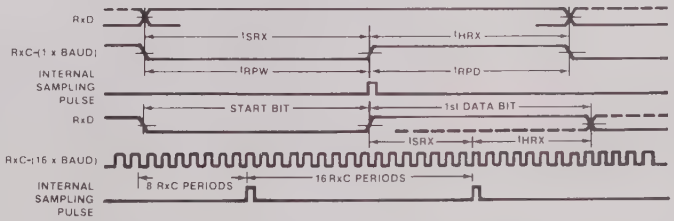


*Write and read pulses have no timing limitation with respect to CLK

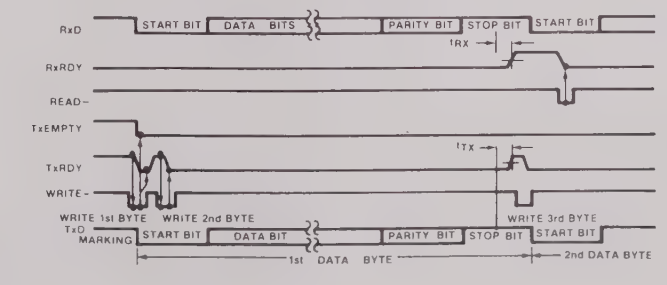
TRANSMITTER CLOCK AND DATA



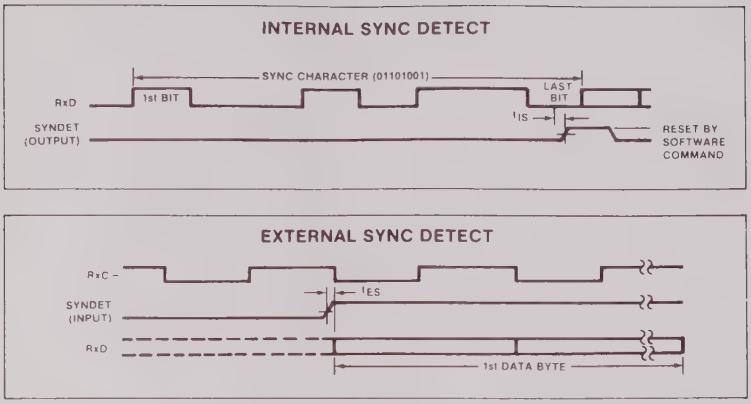
RECEIVER CLOCK AND DATA



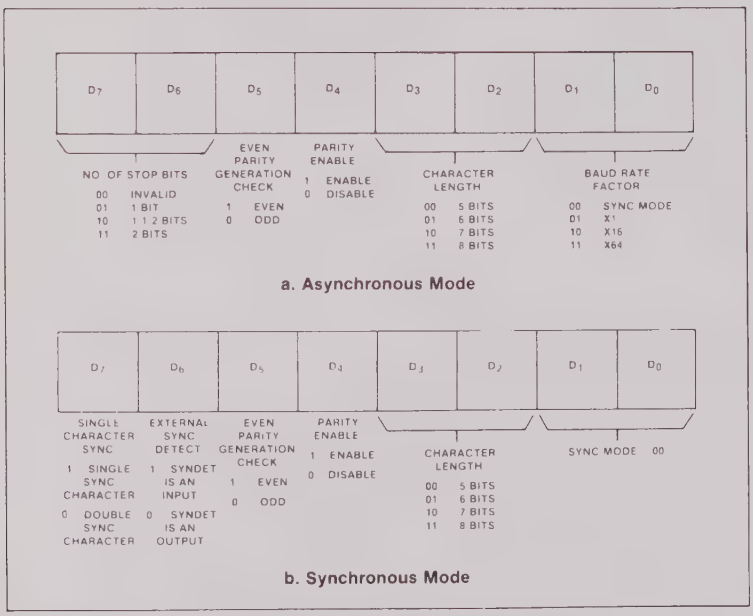
TxRDY AND RxRDY TIMING (ASYNC MODE)



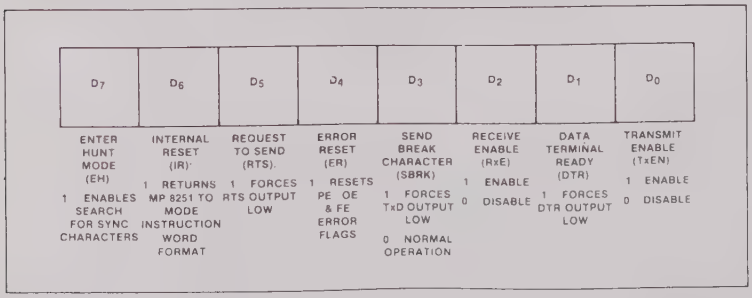
TIMING WAVEFORMS (Cont.)



MODE INSTRUCTION CONTROL WORD FORMAT



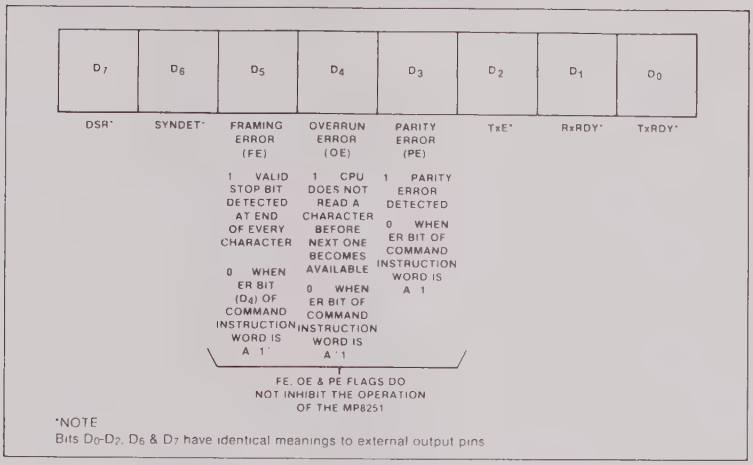
COMMAND INSTRUCTION CONTROL WORD FORMAT


D7 D6 D5 D4 D3 D2 D1 D0
ENTER HUNT MODE (EH)
1 ENABLES SEARCH FOR SYNC CHARACTERS
INTERNAL RESET (IR)
1 RETURNS MP 8251 TO MODE INSTRUCTION WORD FORMAT
REQUEST TO SEND (RTS)
1 FORCES RTS OUTPUT LOW
ERROR RESET (ER)
1 RESETS PE OE & FE ERROR FLAGS
SEND BREAK CHARACTER (SBRK)
1 FORCES TxD OUTPUT LOW
0 NORMAL OPERATION
RECEIVE ENABLE (RxE)
1 ENABLE
0 DISABLE
DATA TERMINAL READY (DTR)
1 FORCES DTR OUTPUT LOW
TRANSMIT ENABLE (TxEN)
1 ENABLE
0 DISABLE

MP8251 STATUS

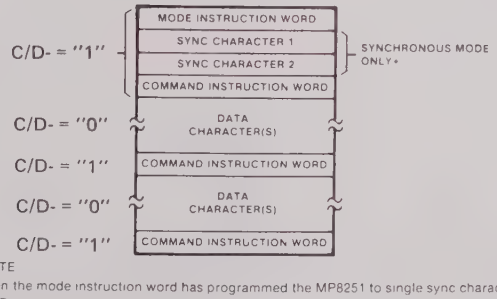
The MP8251 has provisions for allowing the programmer to read the status of the device at any time during the functional operation. When the C/D— input is a high-level, a normal read operation is executed to read this status information. The figure below shows the bits in the Status Read Word format. Since some of the status word bits have identical meaning to external output pins, the MP8251 can be used in a completely polled environment or in an interrupt driven environment.

STATUS READ WORD FORMAT


D7
D6
D5
D4
D3
D2
D1
D0
DSR*
SYNDET*
FRAMING ERROR (FE)
OVERRUN ERROR (OE)
PARITY ERROR (PE)
TxE*
RxRDY*
TxRDY*
1 VALID STOP BIT DETECTED AT END OF EVERY CHARACTER
0 WHEN ER BIT (D4) OF COMMAND INSTRUCTION WORD IS A '1'
1 CPU DOES NOT READ A CHARACTER BEFORE NEXT ONE BECOMES AVAILABLE
0 WHEN ER BIT OF COMMAND INSTRUCTION WORD IS A '1'
1 PARITY ERROR DETECTED
0 WHEN ER BIT OF COMMAND INSTRUCTION WORD IS A '1'
FE, OE & PE FLAGS DO NOT INHIBIT THE OPERATION OF THE MP8251

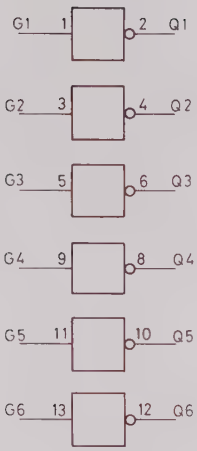
*NOTE
Bits D_0-D_2, D_5 & D_7 have identical meanings to external output pins

TYPICAL DATA BLOCK TRANSFER



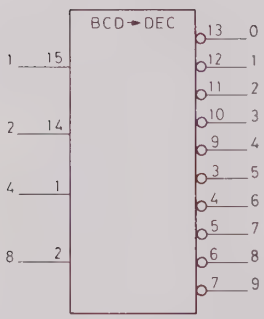
*NOTE
When the mode instruction word has programmed the MP8251 to single sync character (bit D_7 = '1'), sync character 2 is omitted. Both sync characters are omitted in the asynchronous mode

N7406
Hex Inverter
Buffer/Driver
(open collector)



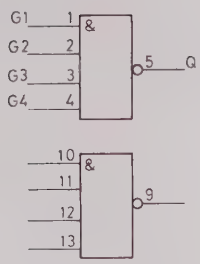
$Q = \overline{G}$

N8251 N
BCD-to-decimal
decoder



BCD				DECIMAL									
1	2	4	8	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	1	1	1	1	1	1	1	1	1
1	0	0	0	1	0	1	1	1	1	1	1	1	1
0	1	0	0	1	1	0	1	1	1	1	1	1	1
1	1	0	0	1	1	1	0	1	1	1	1	1	1
0	0	1	0	1	1	1	1	0	1	1	1	1	1
1	0	1	0	1	1	1	1	1	0	1	1	1	1
0	1	1	0	1	1	1	1	1	1	0	1	1	1
1	1	1	0	1	1	1	1	1	1	1	0	1	1
0	0	0	1	1	1	1	1	1	1	1	1	0	1
1	0	0	1	1	1	1	1	1	1	1	1	1	0
0	1	0	1	1	1	1	1	1	1	1	1	0	1
1	1	0	1	1	1	1	1	1	1	1	1	1	0
0	0	1	1	1	1	1	1	1	1	1	1	0	1
1	0	1	1	1	1	1	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1	1	1	1	1	0

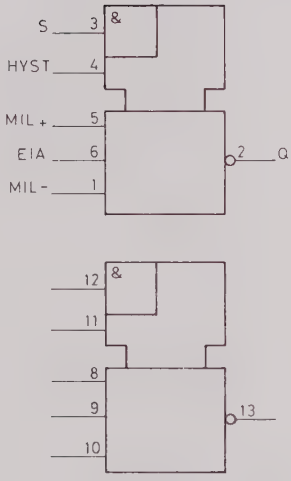
N8T15
Dual Communications
EIA/MIL Line Driver



$Q = \overline{G1.\ G2.\ G3.\ G4}$

Q = O when all G inputs = 1
otherwise Q = 1

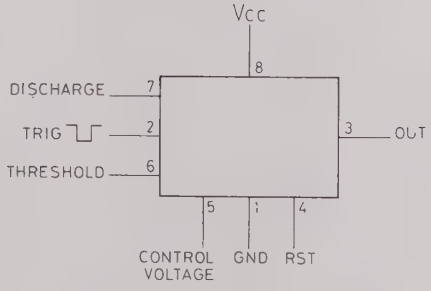
N8T16
Dual communications EIA/MIL
Line Receiver with hysteresis



S	EIA	MIL+	MIL−	Q
0	x	x	x	1
1	1	0	0	0
1	0	0	0	1
1	0	1	0	0

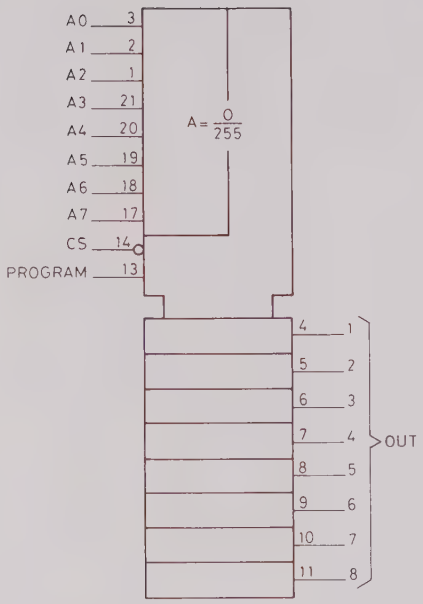
Hyst input can be open or grounded.
This affects the input threshold levels
and the degree of hysteresis

NE555
Timer



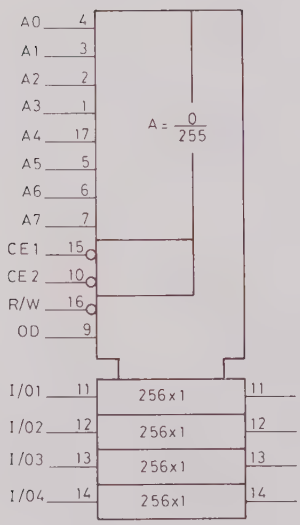
The NE555 can be used as an astable or monostable timer. Timing intervals can be from microseconds to hours.

P1702A
256 x 8-Bit
UV erasable
Programmable read-only
memory



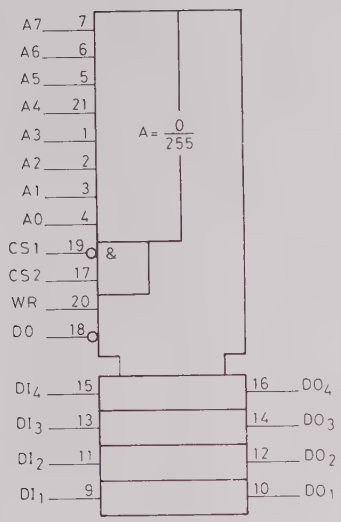
V_{DD} – pin 24
V_{CC} – pin 22, 23, 12
V_{BB} – pin 15
V_{GG} – pin 16

P2111-A4
256 x 4-Bit
STATIC MOS
Random access
memory



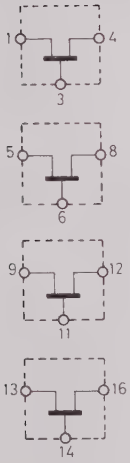
V_{CC} – pin 18
GND – pin 8

P5101L-1
256 x 4-Bit Static
CMOS RAM



V_{CC} – pin 22
GND –pin 8

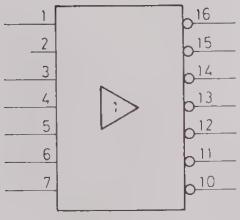
SD5000B
Quad D-MOS FET
Switch



"On" resistance ≈ 30 Ω
"Off" resistance > 10^9 Ω

Common
Substrate – pin 2

ULN2002
7-segment
darlington
driver



V_{CC} – pin 9
Ground – pin 8

4.1.2. List of mnemonics

*AUT	RATEMETER RANGE, AUTORANGING SELECTOR BIT *	(* = A, B, C, D)
*LTEN	FOR TENS OF LOWER LEVEL	(* = A, B, C, D)
*LUNT	FOR UNITS OF LOWER LEVEL	(* = A, B, C, D)
*MAN	RATEMETER RANGE, MANUAL SELECTOR BIT *	(* = A, B, C, D)
*REM	RATEMETER RANGE, REMOTE SELECTOR BIT *	(* = A, B, C, D)
*WTEN	FOR TENS OF WINDOW SETTING	(* = A, B, C, D)
*WUNT	FOR UNITS OF WINDOW SETTING	(* = A, B, C, D)
.... VE	SUFFIX "... VOLTS FOR ELECTRONICS"	
.... VM	SUFFIX "... VOLTS FOR MOTORS"	
.... VS	SUFFIX "... VOLTS FOR SWITCHING TRANSISTORS"	
.... VV	SUFFIX "... VOLTS FOR VALVES"	
... GEN	SUFFIX "... VOLTS SUPPLIED BY GENERATOR"	
... VPA	SUFFIX "... VOLTS FOR PRE-AMPLIFIER"	
... VSB	SUFFIX "... VOLTS FOR STAND BY CIRCUITS"	
.. VVSB	SUFFIX "... VOLTS FOR VALVES IN STAND BY CIRCUITS"	
. GENSW	SUFFIX "... VOLTS SUPPLIED BY GENERATOR, SWITCHED"	
010 HZ	10 Hz	
10 KHZ	10 kHz	
400 Hz	400 HERZ SIGNAL	
5VP	5 VOLT SUPPLY FOR RANDOM ACCESS MEMORY	
A*	MICROCOMPUTER ADDRESS BUS BIT *	(* = 0 . . . 15)
ADEC*	COUNTER TIMER DATA BIT *	(* = 1, 2, 4, 8)
ADRB*	ADDRESS BUS BYTE SELECTION BIT *	(* = 0 . . . 3)
ADRM*	ADDRESS BUS MODULE SELECTION BIT *	(* = 0 . . . 3)
ALAIR	AIRLOCK AIR INLET VALVE	
ALE	ADDRESS LATCH ENABLE (= SYNC FROM MICROCOMPUTER)	
ALVAC	AIRLOCK VACUUM VALVE	
AMPLS	A-CHANNEL MOTOR PULSE	
ANLYS	ANALYSE LAMP (AUTOMATIC MEASURING PROGRAM IS RUNNING)	
ANRED	ANGLE READ	
ANWRT	ANGLE WRITE	
ARDOC	ARM DECOUPLING OR COUPLING	
ASCB*	AUTOMATIC SAMPLE CHANGER DATA BYTE BIT *	(* = 1 . . . 8)
ASCCP	AUTOMATIC SAMPLE CHANGER CONTROL PRESENT	
ASCI*	ASCII CODE DIGIT BIT *	(* = 1 . . . 6)
ASCON	AUTOMATIC SAMPLE CHANGER "ON"	
ASCPR	AUTOMATIC SAMPLE CHANGER PRESENT	
ATTVR	ATTENUATION VOLTAGE REFERENCE	
ATTVS	ATTENUATION VOLTAGE AFTER "ATTENUATION" SWITCH	
ATTVT	ATTENUATION VOLTAGE	
ATTVX	ATTENUATION VOLTAGE AFTER X-TAL AND ORDER SELECTION	
B1SLT	BUSY-TRAY TRANSPORT MOTOR 1 SPECTROMETER SIDE SHIFT LEFT	
B1SRT	BUSY-TRAY TRANSPORT MOTOR 1 SPECTROMETER SIDE SHIFT RIGHT	
B4HMO	BUSY-GRAB MOTOR 4 HORIZONTAL MOVEMENT	
B4HLD	BUSY-GRAB MOTOR 4 HORIZONTAL LOADING	
B4HUD	BUSY-GRAB MOTOR 4 HORIZONTAL UNLOADING	
BBUCB	BYTE BUSY CIRCUIT	
BDEC*	COUNTER TIMER DECADE SELECTOR BIT *	(* = 1, 2, 4, 8)
BGRBB	BYTE GRAB POSITION BUFFER	
BLANK	DISPLAY BLANK	
BMPLS	B-CHANNEL MOTOR PULSE	
BORPB	BYTE OPTICAL READER PROGRAM NUMBER BUFFER	
BORTB	BYTE OPTICAL READER TRAY IDENTIFICATION BUFFER	
BSEL*	BIT SELECTOR BIT *	(* = 0, 1)
BTRAB	BYTE TRAY POSITION BUFFER	
BUSSY	BUSY-SYSTEM	

BUSYL	BUSY LINE	
BYTE*	BYTE * SELECTED	(* = 0 . . . F)
CALBR	CALIBRATE STEPPING MOTOR	
CALBR	CALIBRATE AMPLIFIER/ANALYZER	
CAPBY	CAP BUSY	
CAPHI	CAP HIGH	
CAPLO	CAP LOW	
CAPVD	CAP "DOWN" VALVE	
CAPVU	CAP "UP" VALVE	
CARMO	CARROUSSEL (SAMPLE TURRET) MOTOR ON	
CARP*	CARROUSSEL (SAMPLE TURRET) POSITION BIT *	(* = A, B)
CARST	CARROUSSEL (SAMPLE TURRET) IN REST	
CLEAR	CLEAR SIGNAL FROM MICROCOMPUTER (=RESET) (=PON)	
CLOCK	CLOCK PULSE FROM MICROCOMPUTER (=CLK) (=PHI2N)	
CNTP1	COUNT PULSE (GATING SIGNAL FOR CNTP5)	
CNTP5	COUNTER PULSE TRAIN (5 PULSES) FROM STEPPER MOTOR	
CNTUP	COUNT UPWARD	
COCSD	COARSE COLLIMATOR SELECTED	
COFSD	FINE COLLIMATOR SELECTED	
COLBY	COLLIMATOR BUSY	
COLVC	COLLIMATOR VALVE "COARSE"	
COLVF	COLLIMATOR VALVE "FINE"	
CS*	CHIP SELECT *	(*= 0 . . . 7)
CS1LOW	CHIP SELECT 1 LOWER 1K	
CS1UPP	CHIP SELECT 1 UPPER 1K	
CS2–*	CHIP SELECT 2 – RAM PAIR *	(*= 0 . . . 3)
CTENB	COUNTER ENABLE	
CTPLS	COUNT PULSE FOR POSITION CONTROL	
CTS106	CLEAR TO SEND 106 (RS232C) (=READY FOR SENDING)	
CTTIM	COUNT PULSE FOR TIMER	
D*	MICROCOMPUTER DATA BUS BIT *	(*= 0 . . . 7)
DBIN	MICROCOMPUTER CONTROL BUS "READ" SIGNAL (=RD)	
DCD109	DATA CARRIER DETECTED 109 (RS232C)	
DEC*		
DEGRM	DEGREE MARKER	
DETSF	DETECTOR SIGNAL FROM FLOW DETECTOR	
DETSS	DETECTOR SIGNAL FROM SCINTILLATION DETECTOR	
DIRDN	DIRECTION DOWN	
DIRUP	DIRECTION UP	
DISB*	DISPLAY BIT *	(*= 1, 2, 4, 8)
DISPA	DISPLAY ANGLE	
DISPC	DISPLAY COUNTS	
DISPT	DISPLAY TIME	
DISPV	DISPLAY VACUUM	
DISWR	DISPLAY WRITE PULSE	
DSEL*	DIGIT SELECTOR BIT *	(*= 1, 2, 4)
DSR107	DATA SET READY 107 (RS232C)	
DTR108	DATA TERMINAL READY 108.2 (RS232C)	

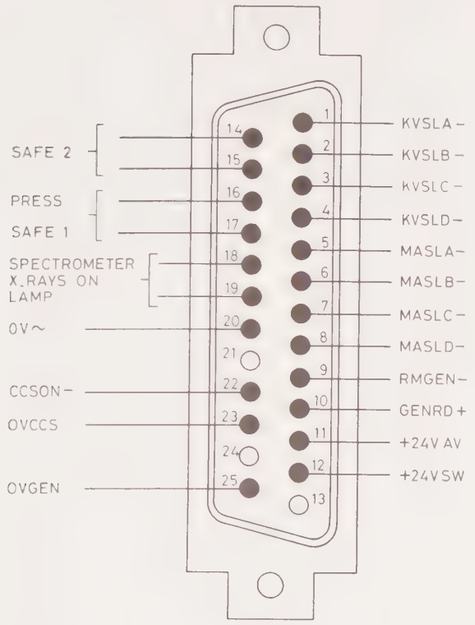
EGRBB	ENABLE GEAB POSITION BUFFER	
EORPB	ENABLE OPTICAL READER: PROGRAM NUMBER BUFFER	
EORTB	ENABLE OPTICAL READER: TRAY IDENTIFICATION BUFFER	
EQUAL	STEPPING MOTOR POSITION EQUALS SETPOINT	
ERROR	STEPPING MOTOR ERROR	
ETRAB	ENABLE TRAY POSITION BUFFER	
FGD101	FRAME GROUND 101 (RS232C)	
FILBY	FILTER BUSY	
FILNS	FILTER NOT SELECTED	
FILSD	FILTER "IN" SELECTED	
FILVO	FILTER VALVE "OUT"	
GASOF	GAS CIRCUIT SWITCHED OFF (GAS LEAKAGE)	
GASOK	DETECTOR GAS O.K.	
GENRD	GENERATOR READY	
GM4HL	GRAB MOTOR 4: HORIZONTAL MOVEMENT OF LOAD CYCLE	
GM4HU	GRAB MOTOR 4: HORIZONTAL MOVEMENT OF UNLOAD CYCLE	
GM5VT	GRAB MOTOR 5: VERTICAL MOVEMENT OF LOAD OR UNLOAD CYCLE	
GND	GROUND	
HEATR	HEATER ON	
HELBY	HELIUM SYSTEM BUSY	
HELV*	HELIUM VALVE * (*= 1 . . . 5)	
HLDA	HOLD ACKNOWLEDGED	
HOLD	HOLD REQUEST	
INSTC	INHIBIT STOP CONDITION	
INT	INTERRUPT REQUEST	
INTA	INTERRUPT ACKNOWLEDGED	
INTE	INTERRUPT ENABLED	
INTR*	INTERRUPT REQUEST FROM DEVICE *	(*= 2 . . . 7)
IOBU*	EQUIPMENT DATA BUS BIT *	(*= 0 . . . 7)
IORED	EQUIPMENT CONTROL BUS "READ" SIGNAL	
IOWRT	EQUIPMENT CONTROL BUS "WRITE" SIGNAL	
KVSL*	KV-SELECTOR BIT *	(*= A, B, C, D)
LLREC	LOWER LEVEL OUTPUT TO RECORDER	
LLTEN	1, 2, 4 OR 8 BIT FOR TENS OF LOWER LEVEL	
LLUNT	1, 2, 4 OR 8 BIT FOR UNITS OF LOWER LEVEL	
LORON	LAMPS OFF ICAL READER ON	
LWLIM	LOWER LIMIT	
LOWLV	LOWER LEVEL VOLTAGE (= LWLEV)	
LSTFF	LAST STEP FLIP FLOP	
LWLEV	LOWER LEVEL VOLTAGE (= LOWLV)	
M200D	MOTOR REQUIRES 200 STEPS PER $^{o}2\theta$	
M200R	MOTOR DRIVE REQUIRING 200 STEPS PER REVOLUTION	
MASL*	MA-SELECTOR BIT *	(*= A, B, C, D)
MCOL*	MOTOR COIL *	(*= A, B, C, D)
MONTB	MONITOR TRAY BUSY	
MOTHV	MOTOR HIGH VOLTAGE	
MOTOR	COMMON MOTOR COILS CONNECTION	
MSK*B	COLLIMATOR MASK * SELECTED	(*= 1,2)
MSKBY	COLLIMATOR MASK BUSY	
MSKV1	COLLIMATOR MASK "1" VALVE	
MSKV2	COLLIMATOR MASK "2" VALVE	
MTMLP	MONITOR TRAY MOVEMENT TO LOADING POSITION	
MTMRP	MONITOR TRAY MOVEMENT TO REST POSITION	

OSC	OSCILLATOR (CLOCK FREQUENCY)
PASET	PARAMETERS ARE SET
PBAIR	PUSH BUTTON "AIR" MODE
PBHEL	PUSH BUTTON "HELIUM" MODE
PBVAC	PUSH BUTTON "VACUUM" MODE
PHDIV	PULSE HEIGHT DIVISION (SUPPRESS PULSE SHIFT CORR.)
PHDVR	PULSE HEIGHT DIVISION ON RECORDER
PHI1	CLOCK PHASE 1 (NON-TTL LEVEL)
PHI1N	CLOCK PHASE 1 (NORMAL TTL COMPATIBLE)
PHI2	CLOCK PHASE 2 (NON-TTL LEVEL)
PHI2N	CLOCK PHASE 2 (NORMAL TTL COMPATIBLE)
PLUBY	PLUNGER BUSY
PLUEN	PLUNGER ENABLE
PLUHI	PLUNGER HIGH
PLULO	PLUNGER LOW
PLUVD	PLUNGER VALVE "DOWN"
PLUVU	PLUNGER VALVE "UP"
PON	POWER ON
PRESS	AIR PRESSURE O.K.
RBSM*	RESET BUSY-MOTOR * (* = 1 . . . 5)
RCPLS	RECORDER PAPER TRANSPORT PULSE (= RECCH)
RD	MICROCOMPUTER CONTROL BUS "READ" SIGNAL (= DBIN)
RD104	RECEIVED DATA 104 (RS232C)
READY	µCOMP. and EQUIPM. CONTROL BUS "READY" (HANDSHAKE)
RECCH	RECORDER PAPER TRANSPORT PULSE (= RCPLS)
RECHI	"HIGH" OF SIGNAL TO RECORDER
RECLO	"LOW" OF SIGNAL TO RECORDER
RECOF	RECORDER "OFF" (STOP TRANSPORT AND KILL SERVO)
REDMO	READ MODULE
REMGN	REMOTE CONTROL GENERATOR
RESCT	RESET COUNTER
RESET	RESET SIGNAL (= CLEAR) (= PON)
RESGS	RESET GAS LEAKAGE DETECTOR
RESIN	RESET INPUT FOR MICROCOMPUTER
RMAUR	RATEMETER RANGE MANUALLY SELECTED: AUTORANGING
RMFT*	RATEMETER RANGE MANUALLY SELECTED: FACTOR BIT * (*= A, B)
RMPW*	RATEMETER RANGE MANUALLY SELECTED: POWER BIT * (*= C, D, E)
RRAUT	RATEMETER IS AUTORANGING
RRFT*	RATEMETER RANGE FACTOR BIT * (* = A, B,)
RRPW*	RATEMETER RANGE POWER BIT * (* = C, D)
RTC**	RATEMETER TIME CONSTANT ** (** = .1 . . . 10)
RTCAU	RATEMETER TIME CONSTANT AUTOMATIC
RTGOR	READ TRANSPORT GRAB OR OPTICAL READER
RTMHI	"HIGH" OF RATE METER SIGNAL
RTMLO	"LOW" OF RATE METER SIGNAL
RTS105	REQUEST TO SEND 105 (RS232C)
RXRDY	RECEIVER READY (CHAR. IN INPUT BUFFER) (=INTR6 OR INTR 7)
SAFE*	SAFETY CIRCUIT * CLOSED (*= 1, 2)
SCAN	SCAN
SCANP	SCAN PULSE
SCCAD	SAMPLE CHANGER CONTROL ADDRESS
SECH*	SHAFT ENCODER CHANNEL * (* = A, B, C)
SGD102	SIGNAL GROUND 102 (RS232C)
SLBUS	EQUIPMENT BUS SELECTED (BUS ACTIVE)

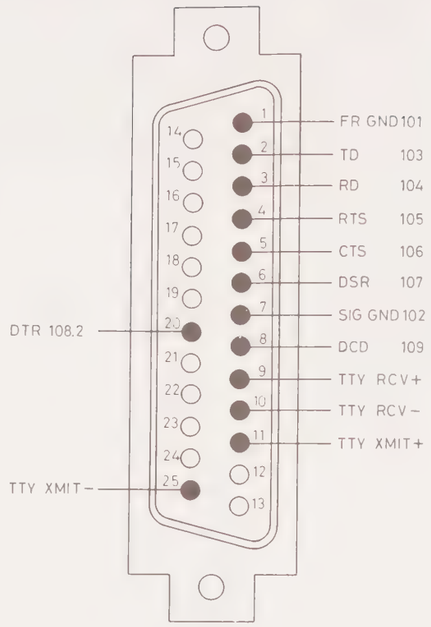
SLCOM	SLOW SPEED STEPPER MOTOR MICRO COMPUTER MODE
SLFCD	SELECT FLOW DETECTOR
SLINT	SELECT INTERRUPT RESET WORD
SLOR1	SELECT FIRST ORDER
SLSCD	SELECT SCINTILLATION DETECTOR
SLSIF	SELECT SERIAL INTERFACE
SMERR	STEPPER MOTOR ERROR
SMLOW	STEPPER MOTOR LOW SPEED
SMRDY	STEPPER MOTOR READY
SMWRT	WRITE PULSE FOR STEPPING MOTOR CONTROL WORD
SPG4H	STOP GRAB MOTOR 4 HORIZONTAL MOVEMENT
SPG5V	STOP GRAB MOTOR 5 VERTICAL MOVEMENT
SPINM	SPINNER MOTOR ON
SPT1S	STOP TRANSPORT MOTOR 1 AT SPECTROMETER SIDE
SPT2F	STOP TRANSPORT MOTOR 2 AT FRONT SIDE SHIFT LEFT
SPT3Q	STOP TRANSPORT MOTOR 3 QUEUE TRAYS UP
SRTFF	START FLIP FLOP COUNTER TIMER
SSCAN	STEPPER MOTOR SCAN
STEP5	STEP (= 0.005 DEGREE 2 THETA) PULSE FROM GONIOMETER
STRED	STATUS READ
STRGM	START GRAB MOVEMENT
STRML	START MONITOR TO LOADING POSITION
STRMR	START MONITOR TO REST POSITION
STRTP	START TRANSPORT MOVEMENT
SUCAP	SAMPLE UNDER CAP
SYNC	SYNCHRONIZATION SIGNAL FROM MICROCOMPUTER (= ALE)
SYSBY	SYSTEM BUSY (ANY OF THE PARAMETERS ON THIS P.C. BOARD)
SZERO	STEPPER MOTOR ZERO
TD103	TRANSMITTED DATA 103 (RS232C)
TIME*	ERROR DELAY TIME * EXPIRED (*= 1 OR 2)
TM1SL	TRAY TRANSPORT MOTOR 1 AT SPECTR. M. SIDE: SHIFT LEFT
TM1SR	TRAY TRANSPORT MOTOR 1 AT SPECTR M. SIDE: SHIFT RIGHT
TM2FL	TRAY TRANSPORT MOTOR 2 AT FRONT SIDE: SHIFT LEFT
TM3QU	TRAY TRANSPORT MOTOR 3: QUEUE TRAYS UP
TTYRCV	CURRENT LOOP RECEIVER
TTYXMT	CURRENT LOOP TRANSMITTER
TXRDY	TRANSMITTER READY
UPLEV	UPPER LEVEL VOLTAGE (=UPPLV)
UPLIM	UPPER LIMIT
UPPLV	UPPER LEVEL VOLTAGE (= UPLEV)
VACBY	VACUUM SYSTEM BUSY
VACOK	VACUUM O.K.
VACON	VACUUM PUMP ON
VCMHI	"HIGH" OF VACUUM METER SIGNAL
VCMLO	"LOW" OF VACUUM METER SIGNAL
WAIT	MICRO COMPUTER CONTROL COMMAND
WATR*	WATER VALVE * (*= 1,2)
WR	MICROCOMPUTER CONTROL BUS "WRITE" SIGNAL
WWINF	WINDOW INFINITE
WWOUT	WINDOW OUTPUT (OUTPUT FROM DISCRIMINATOR)
WWTEN	1, 2, 4 OR 8 BIT FOR TENS OF WINDOW
WWUNT	1, 2, 4 OR 8 BIT FOR UNITS OF WINDOW

XL*SD	CRYSTAL * SELECTED	(* = 1 . . . . 6)
XLMCC	CRYSTAL SELECTOR MOTOR COUNTER CLOCKWISE	
XLMCW	CRYSTAL SELECTOR MOTOR CLOCKWISE	
XSAIR	CRYSTAL AND SAMPLE CHAMBER AIR INLET	
XSVAC	CRYSTAL AND SAMPLE CHAMBER VACUUM VALVE	
XTLBS	CRYSTAL BUSY	
XTLBY	CRYSTAL BUSY	
XTLMO	CRYSTAL MOTOR	
Ø *	CLOCK PHASE * (*= 1 OR 2) (NON-TTL LEVEL)	
Ø *N	CLOCK PHASE * (*= 1 OR 2) (NORMAL TTL COMPATIBLE)	

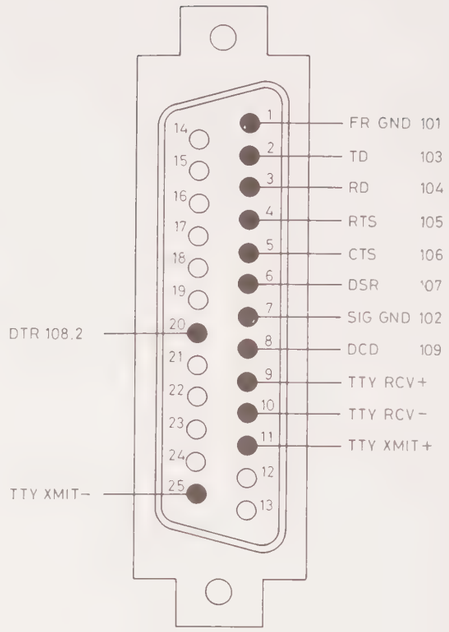
4.1.3 External Electrical Connections



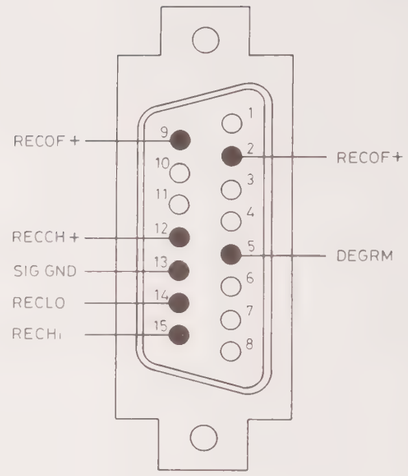
X103
X_RAY GENERATOR



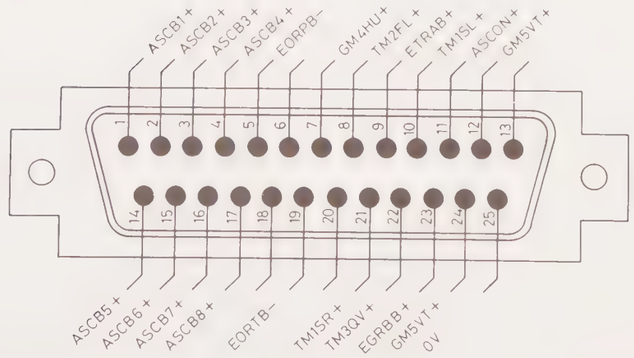
X104
PERIPHERAL



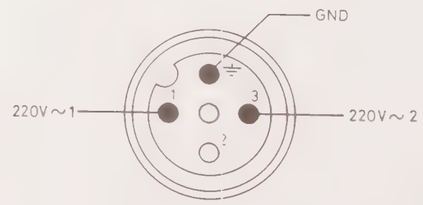
X105
OPTIONAL 2nd PERIPHERAL
(PRINTER ONLY)



X102
CHART RECORDER



X111
SAMPLE CHANGER



X110
SAMPLE CHANGER

RD3700

Fig. 4.1.3. External electrical Connectors

4.1.4. List of fuses

Fuse	Circuit function	
Spectrometer rear panel		
F1	220 V ~	10 A delayed E27
F2	220 V ~	10 A delayed E27
F3	Safety circuit	Thermal cut out
F4	20 V M ~ 2	4 A delayed
F5	5 V M ~ 2	4 A delayed
F6	5 V M ~ 1	4 A delayed
F7	20 V M ~ 1	4 A delayed
F8	12 V ~ 3	4 A delayed
F9	12 V ~ 1	4 A delayed
F10	24 V ~ 1	6,3 A delayed
F11	24 V PA ~ 1	200 mA delayed
F12	5 V 2 ~ 1	4 A delayed
F13	5 V 1 ~ 1	4 A delayed
F14	24 V M ~ 1	1,6 A delayed
F15	24 V SB ~ 1	200 mA delayed
F16	24 V VSB ~ 1	4 A delayed
F17	Not used	–
F18	Not used	–
F19	Not used	–
F20	Not used	–
F21	Not used	–
F22	Not used	–
F23	180 V ~ 1	50 mA delayed
F24	Not used	
F25	220 V ~ 1 sample changer	1,6 A delayed
F26	220 V ~ 2 sample changer	1,6 A delayed
Coil driver pcb A31		
F1	HELV1–	1 A fast
F2	HELV2–	1 A fast
F3	HELV3–	1 A fast
F4	FILVO–	500 mA fast
F5	COLVC–	500 mA fast
F6	COLVF–	500 mA fast
F7	MSKV2–	500 mA fast
F8	MSKV1–	500 mA fast
F9	XSVAC–	500 mA fast
F10	XSAIR–	500 mA fast
Coil driver pcb A32		
F1	ALVAC–	1 A fast
F2	HELV4–	1 A fast
F3	Not used	–
F4	ALAIR–	500 mA fast
F5	PLUVD–	500 mA fast
F6	PLUVU–	500 mA fast
F7	Not used	–
F8	CAPVU	500 mA fast
F9	HELV5–	500 mA fast
F10	CAPVD–	500 mA fast

Motor drive pcb A36

F1	XTLMO ~ 2	1	A delayed
F2	XTLMO ~ 1	1	A delayed
F3	PLUEV ~ 1	1	A delayed
F4	CARMO ~ 1/CARMO ~ 2	1	A delayed
F5	Not used		–
F6	SPINM ~ 1/SPINM ~ 2	1	A delayed

Stepping motor supply-driver pcb A37

F1	MOTOR–	3,15	A fast

Miscellaneous control pcb A38

F1	GASOK–	500	mA fast
F2	WATR1–	1	A fast
F3	WATR2–	1	A fast

4.2. SYSTEM ORGANIZATION

From the organizational point of view, the PW1400/00 can be separated into three main groups:

1. Microcomputer and external interface group
2. Signal processing and control group
3. Eletro-mechanical group

The block diagram fig. 4.2.0.1. and interconnection diagram fig. 4.2.0.2. and 4.2.0.3., show the complete system organization. The microcomputer consists of a CPU (central processor unit) plus PROM pcb and a RAM (random access memory) pcb interconnected by the microcomputer bus.
Also connected to this bus are one or two serial interface pcb's and power supplies.

The signal processing and control group consists of ten pcb's interconnected via the spectrometer bus.
Also connected to this bus is an optional sample changer control pcb.

The mircocomputer bus and the spectrometer bus are interconnected by the bus interface pcb.

The generator control and safety pcb forms an interface between the spectrometer and the PW1730/.. series X-ray generator and for safety reasons also provides galvanic isolation.

The electromechanical group consists of all the motors, electromagnetic valves, and associated mechanical parts. This group is connected to the signal processing and control group pcb's.

In addition to these main groups the spectrometer is provided with a number of power supplies and two independent safety circuits which cause the X-ray generator high voltage to be switched off if an unsafe condition exists in the spectrometer.

The spectrometer is also provided with a number of LED and alphanumeric displays which show the system status.

In this chapter the electrical subsystems are treated individually, so that the combined organization of the signal processing and control group and the electromechanical group can be seen when required.
The microcomputer group is treated separately.

4.3. MICROCOMPUTER SYSTEM

The microcomputer system consists of four or five printed circuit boards as follows:

A 16	CPU + PROM
A 17	RAM
A 20	Interface 1
A 19	Interface 2 (optional)
A 15	Bus interface

These pcb's are mounted in the electrical rack at the top right-hand side of the spectrometer, and are plugged into a mother board which provides all the bus interconnections (see fig. 4.3.0.1.).

The CPU is based on an 8080A microprocessor and is coupled with eight-bit word PROMS having a capacity of 16k words (8 x 2048 words).

The RAM pcb is based on 16 1/4k four-bit word RAM's used in pairs to give a capacity of 2k eight - bit words (16 x 256 words).

Two identical serial interface pcb's can be fitted, one of which is optional. These pcb's provide standard V24 interfacing for peripheral equipment. Interface 1 is bi-directional and can be used to connect the operators terminal (VDU, typewriter, etc). Interface 2 is unidirectional, and can be used to supply information to a second printer or computer.

The bus interface pcb interfaces the spectrometer pcb's to the microprocessor system. It provides timing, level conversion, and interrupt control facilities.

A more detailed block diagram of the microcomputer system is given in fig. 4.3.0.2.

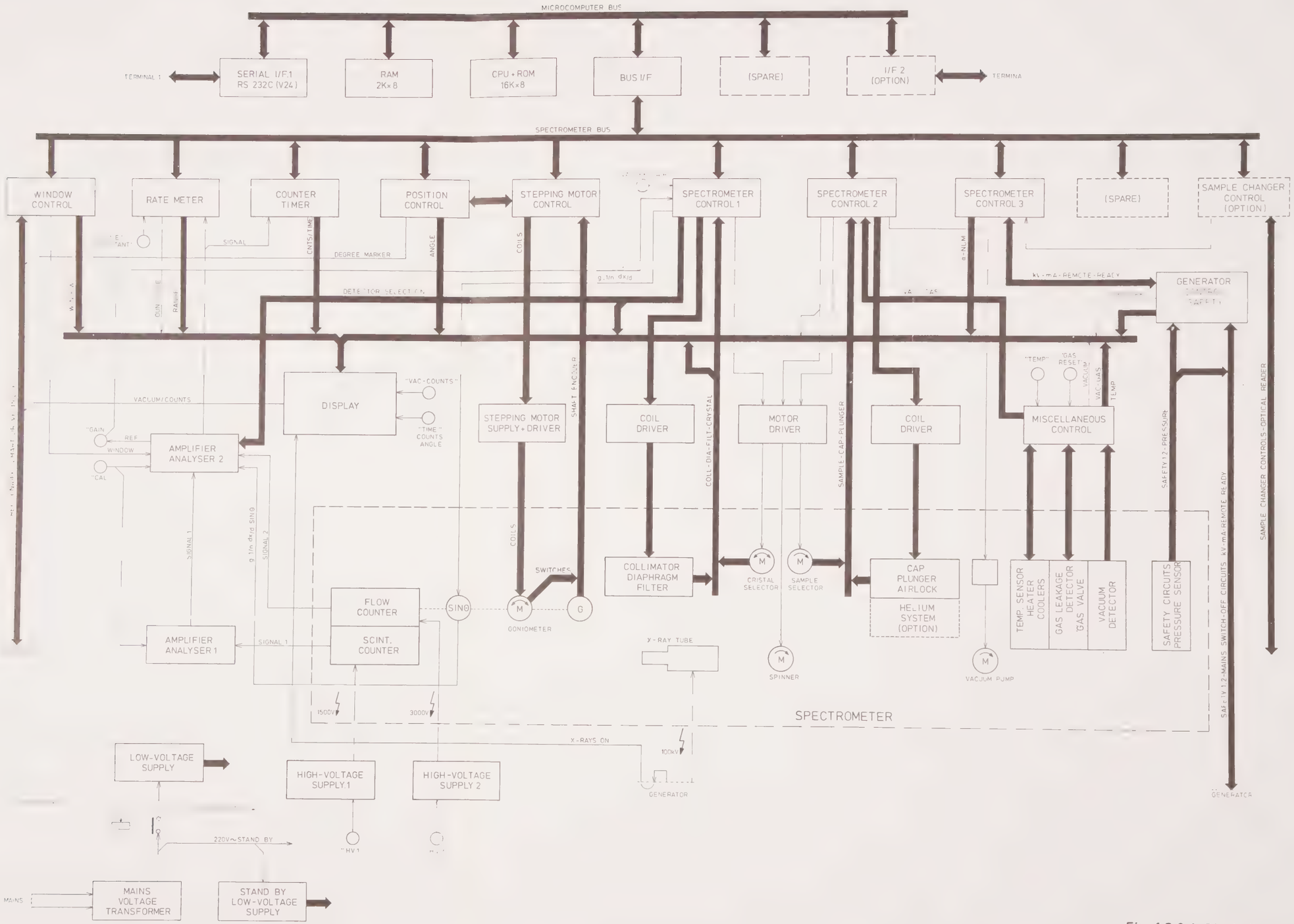
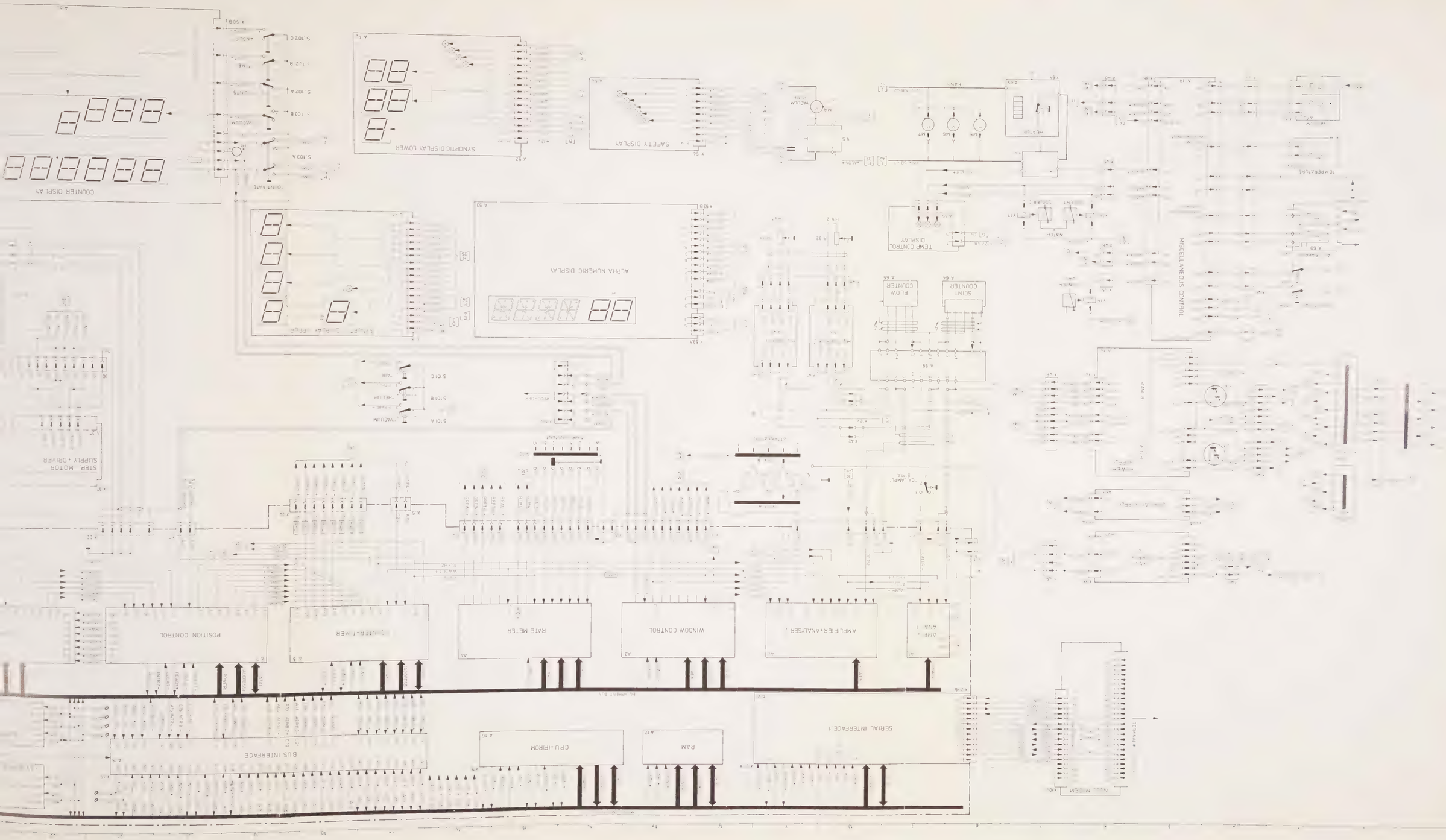


Fig. 4.2.0.1. Block diagram


COUNTER DISPLAY
SYNOPTIC DISPLAY LOWER
SAFETY DISPLAY
ALPHA NUMERIC DISPLAY
TEMP CONTROL DISPLAY
MISCELLANEOUS CONTROL
FLOW COUNTER
SCINT COUNTER
STEP MOTOR SUPPLY + DRIVER
POSITION CONTROL
RATE METER
WINDOW CONTROL
AMPLIFIER+ANALYSER
BUS INTERFACE
CPU+PROM
RAM
SERIAL INTERFACE 1

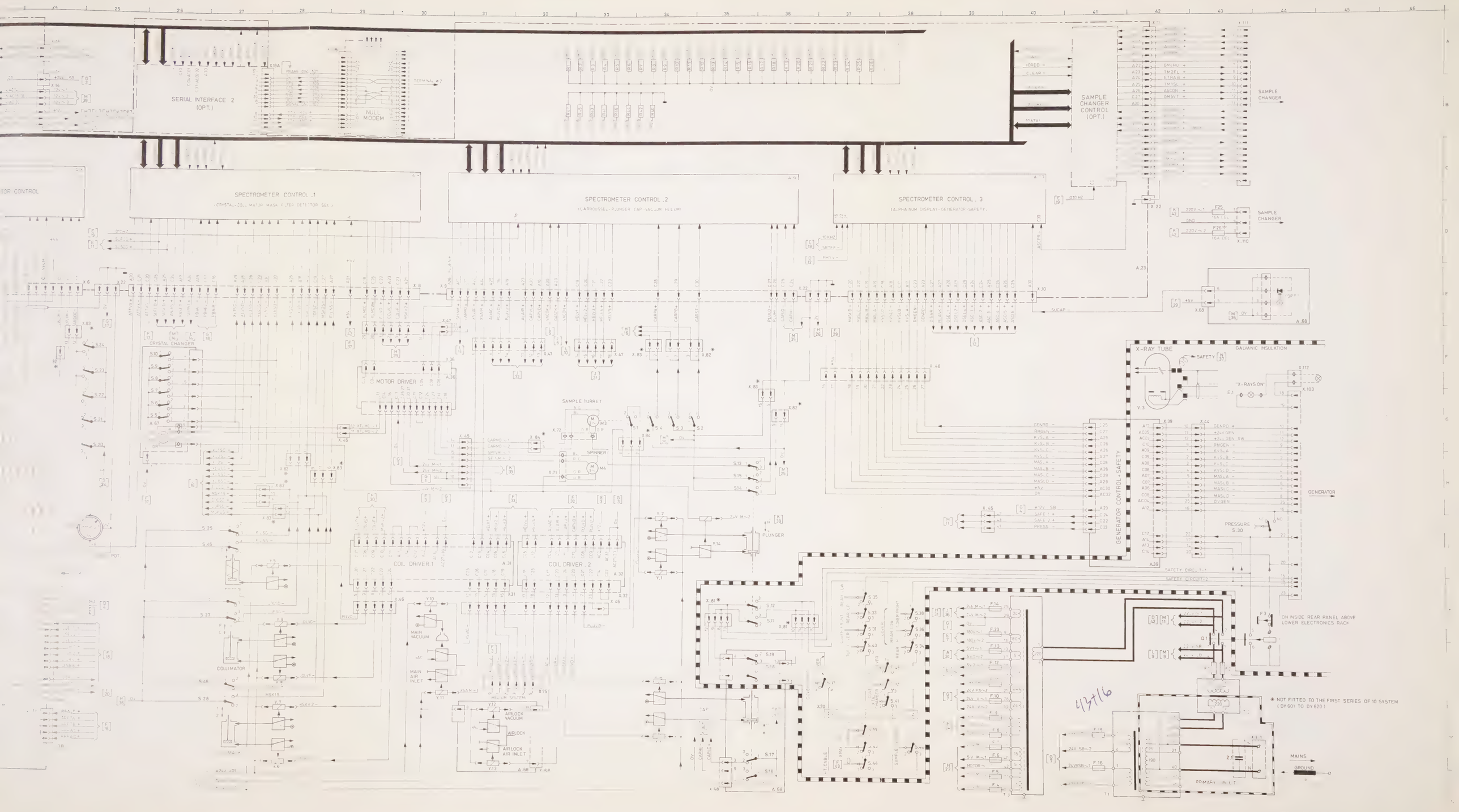
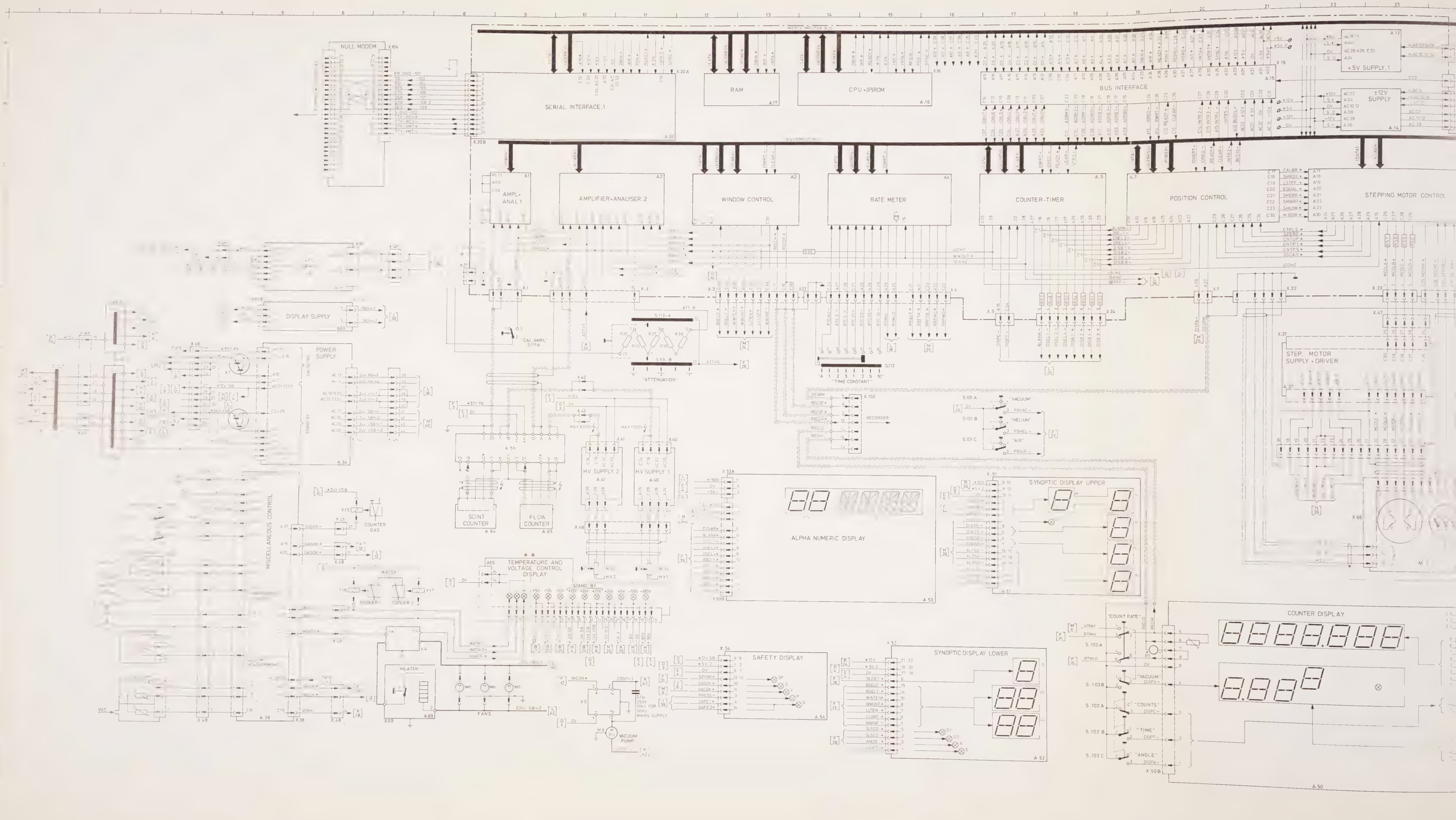


Fig. 4.2.0.2. Interconnection diagram


NULL MODEM
SERIAL INTERFACE.1
RAM
CPU+(P)ROM
BUS INTERFACE
+5V SUPPLY..1
+12V SUPPLY
AMPL+ ANAL.1
AMPLIFIER+ANALYSER.2
WINDOW CONTROL
RATE METER
COUNTER-TIMER
POSITION CONTROL
STEPPING MOTOR CONTROL
DISPLAY SUPPLY
POWER SUPPLY
STEP. MOTOR SUPPLY+DRIVER
"CAL.AMPL"
"ATTENUATION"
"TIME CONSTANT"
RECORDER
"VACUUM"
"HELIUM"
"AIR"
HV SUPPLY 2
HV SUPPLY 1
SCINT. COUNTER
FLOW COUNTER
ALPHA NUMERIC DISPLAY
SYNOPTIC DISPLAY UPPER
MISCELLANEOUS CONTROL
COUNTER GAS
TEMPERATURE AND VOLTAGE CONTROL DISPLAY
STAND_BY
HEATER
FANS
VACUUM PUMP
SAFETY DISPLAY
SYNOPTIC DISPLAY LOWER
"COUNT RATE"
COUNTER DISPLAY
"VACUUM" DISPV
"COUNTS" DISPC
"TIME" DISPT
"ANGLE" DISPA

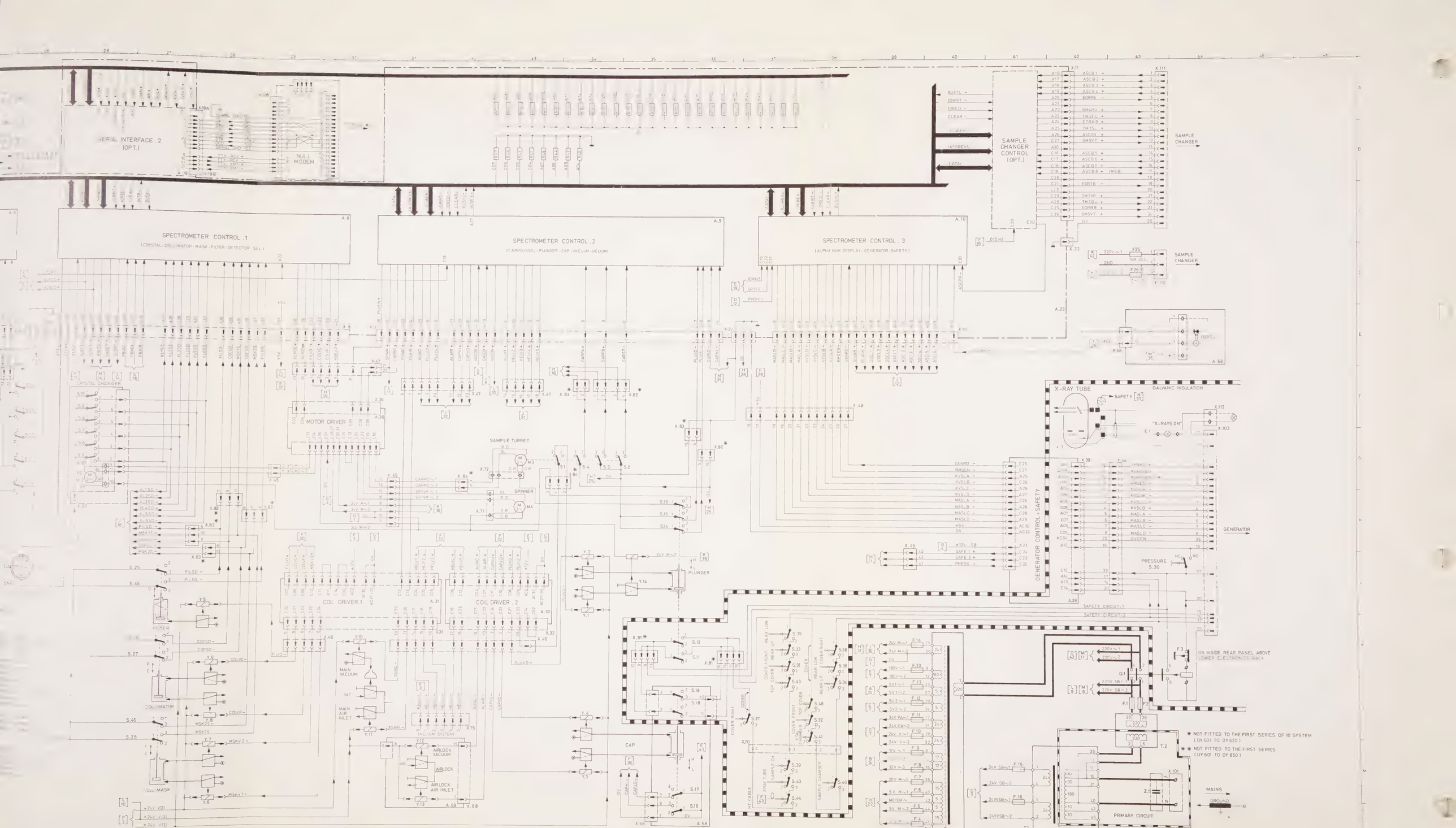


Fig. 4.2.0.3. Interconnection diagram

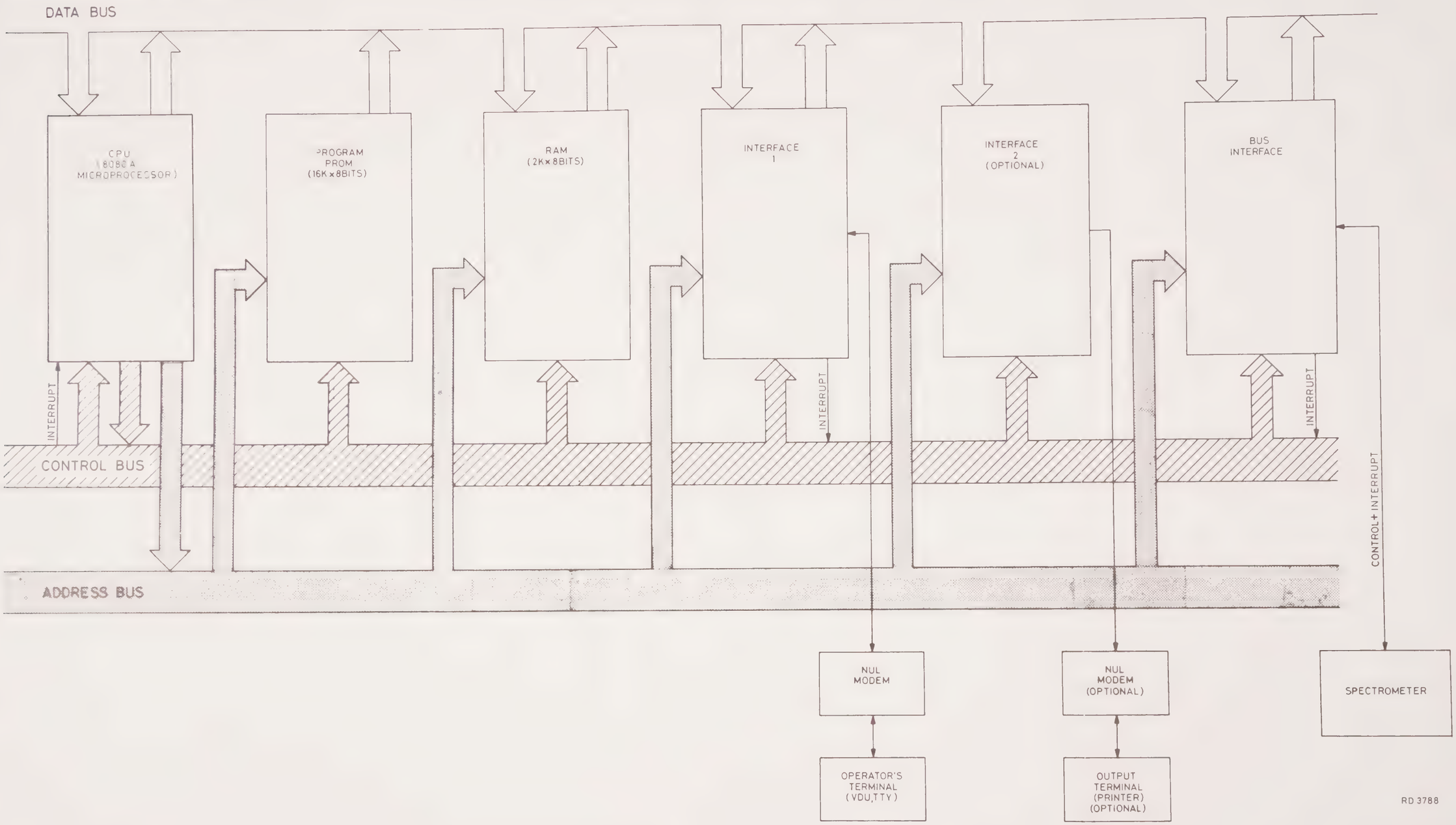


Fig. 4.3.0.1. Interconnections

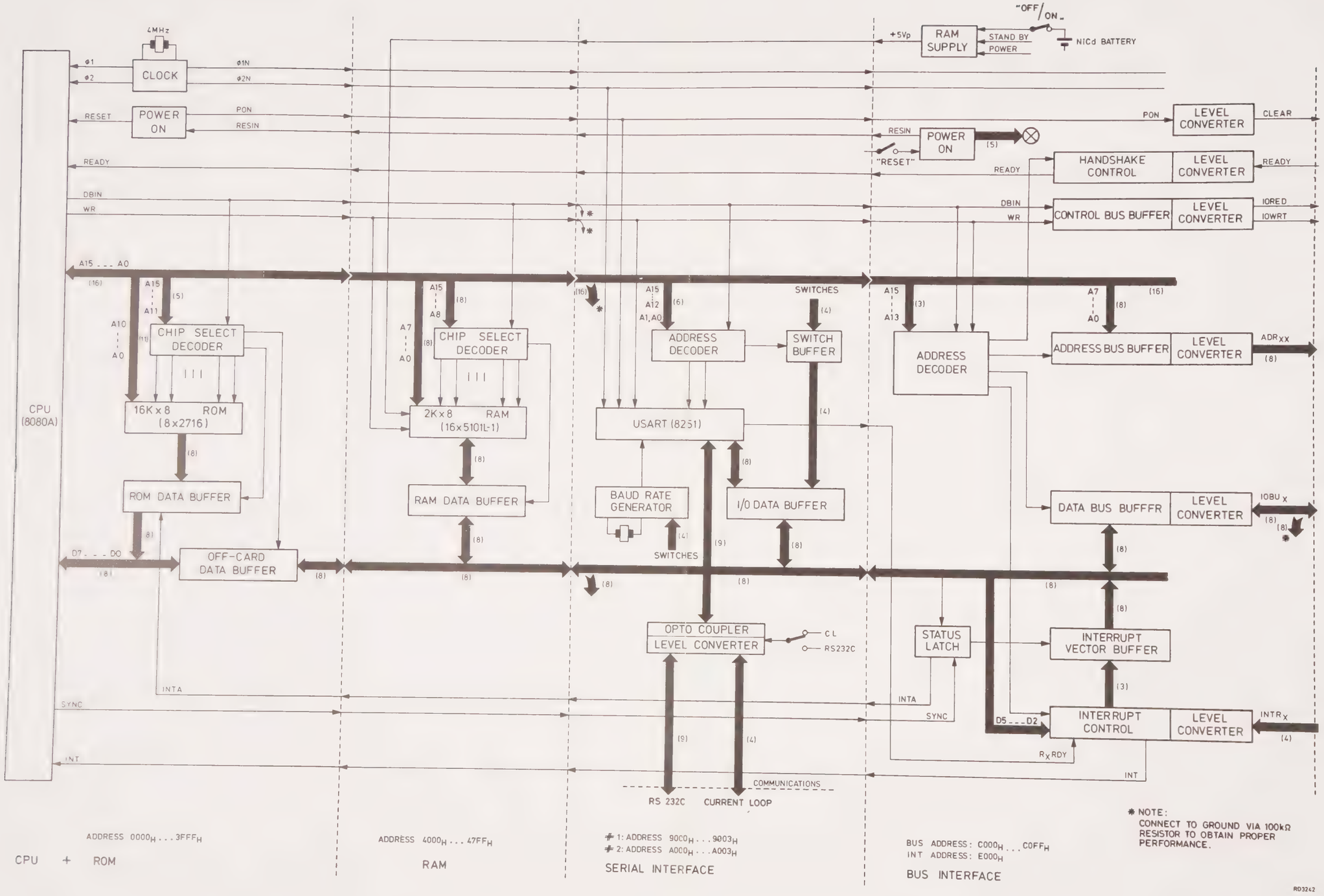


Fig. 4.3.0.2. Block diagram of the microcomputer system

4.3.1. THE CENTRAL PROCESSING UNIT

The CPU is based on an 8080A microprocessor chip, and is coupled with eight-bit word PROMs having a capacity of 16 K words (8 x 2048 words). The spectrometer can be fitted with one of two types of CPU circuit board. The boards are fully compatible and are inter-changeable and have the same ordering number 5322 694 14363. The later manufactured boards have a switch to select 8 K or 16 K PROM, and this switch is situated in the centre of the pcb.

The switch allows universal use with the INTEL 2708 8 x 1 K PROM, or the INTEL 2716 8 x 2 K PROM, but in the PW1400/00 only the type 2716 is used, and the switch selection must be made accordingly.

4.3.1.1. Block diagram

The block diagram of the CPU/ROM, figure 4.3.1.1., shows the flow of data to and from the 8080 microprocessor. The circuit diagram of the universal board (8 K or 16 K PROM switch selection) is shown in figure 4.3.1.2., and the earlier (non-switched) board in figure 4.3.1.3.

4.3.1.2. The clock signal generator

A clock circuit generates the time signal $\Theta 1$ and $\Theta 2$ for the 8080 microprocessor.
The clock generator which is used to drive the CPU consists of an oscillator with gate D13–10 (J/8), and a crystal with a frequency of 3,932160 MHz. The signal from the oscillator is fed via gate D13–4 (J/9) to the D–flip-flop D20–1 (J/10), which produces the signals as shown in figure 4.3.1.4.

The signal of the clock generator has a logic level of 12 V and this level is converted to 5 V via D25 (J/12).

4.3.1.3. The power sensing circuit

The supply voltage which are used on the bus interface are sensed from the signal RESIN–, to give the signal RESET+ to the 8080, also PON– (not true) to reset the status latch on the bus interface. The circuit for the universal board and the non-switched board is different and is described separately below.

4.3.1.4. Universal pcb

The +12 V, +5 V_p, –5 V and +5 V supply voltages, via the diodes V3, V4 and V5, and transistor V1 output, form an AND function. When one of the voltages falls below the trip level (2,3 V) the input 12 of Schmitt trigger D18 will cause D18-11 to go high and reset the 8-bit counter D26. Output 2 of D26 will go low and gate D17–6 gives the RESET+ true signal to the microprocessor. At the same time the power on signal PON– is no longer true and the bus interface status latch is reset. When the system is switched on the RESET+ (and PON–) signal is high until all supply voltages are correct, and will not then go low until eight clock pulses have reset the counter D26 (input 5). The 8080 will now function normally.

The signal RESIN– true will reset the circuit independently of the power sensing, i.e. in the same manner as a falling supply voltage, as the second input of the Schmitt trigger D18.

4.3.1.5. Non-switched pcb

The supply voltage of +5 V on the CPU board is sensed via the operational amplifier D11 (figure 4.3.1.3.) [L/4]. The amplifier is connected as a Schmitt trigger and the output signal of the amplifier will be as shown in figure 4.3.1.5.

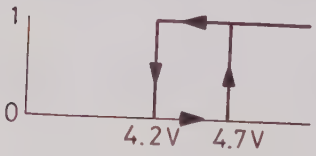


Fig. 4.3.1.5. Operational amplifier output

The signal SUPPLY ON will be high as long as the +5 V supply voltage is less than 4,7 volts.

When the output of the amplifier D11 (L/4) goes up to 5 volts it can be kept low by the signal RESIN– when the other supply voltages on the bus interface have not reached their stabilized value. In this situation the reset input of the counter D15 (L/10) is kept high because the input of D18 is low. The reset of the counter causes output 2 to be low, which results in the signal "RESET+" high via D17–11 (L/11).

The microprocessor is now in its reset condition and this reset remains until the power supply voltages have reached their stabilized values.
When the input 1 of D18 becomes high the reset input of the counter D15 goes low and the counter starts counting. As soon as 8 Ø 2 pulses are counted the enable input 5 is disabled and signal RESET% becomes low via D17–11 so the microprocessor can start executing the instruction which is at memory location 0000.
A high on the reset line will always reset the 8080A to the state T1 and clear the program counter.

These signals are shown in the following table:

RESIN–	+5 V	SUPPLY ON	CPU	D15 counter
0	<4,7 V	1	reset	reset
0	+5 V	1	reset	reset
1	+5 V	1	enabled after 8 Ø 2 pulses	starts counting

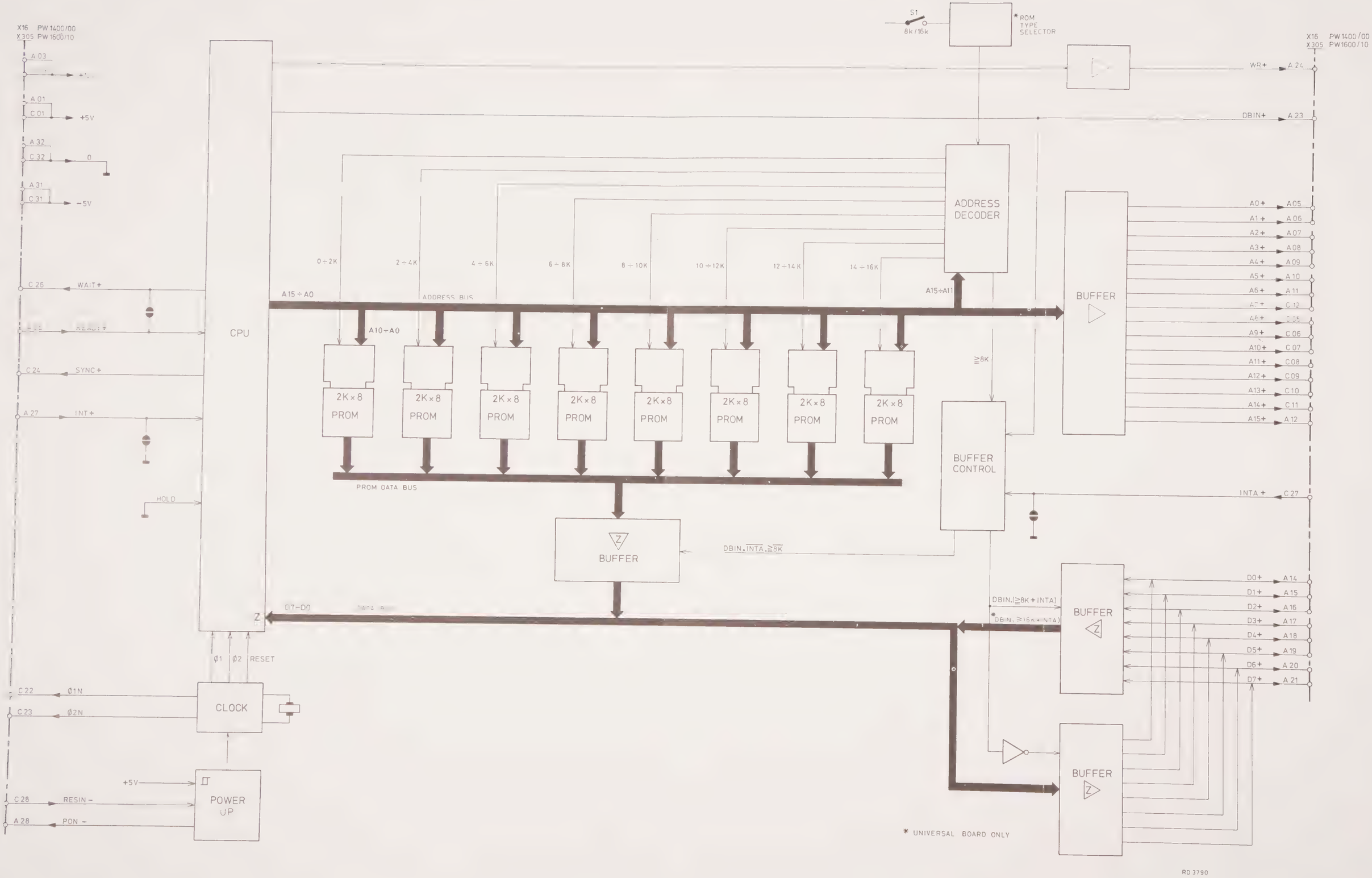


Fig. 4.3.1.1. CPU/ROM block diagram

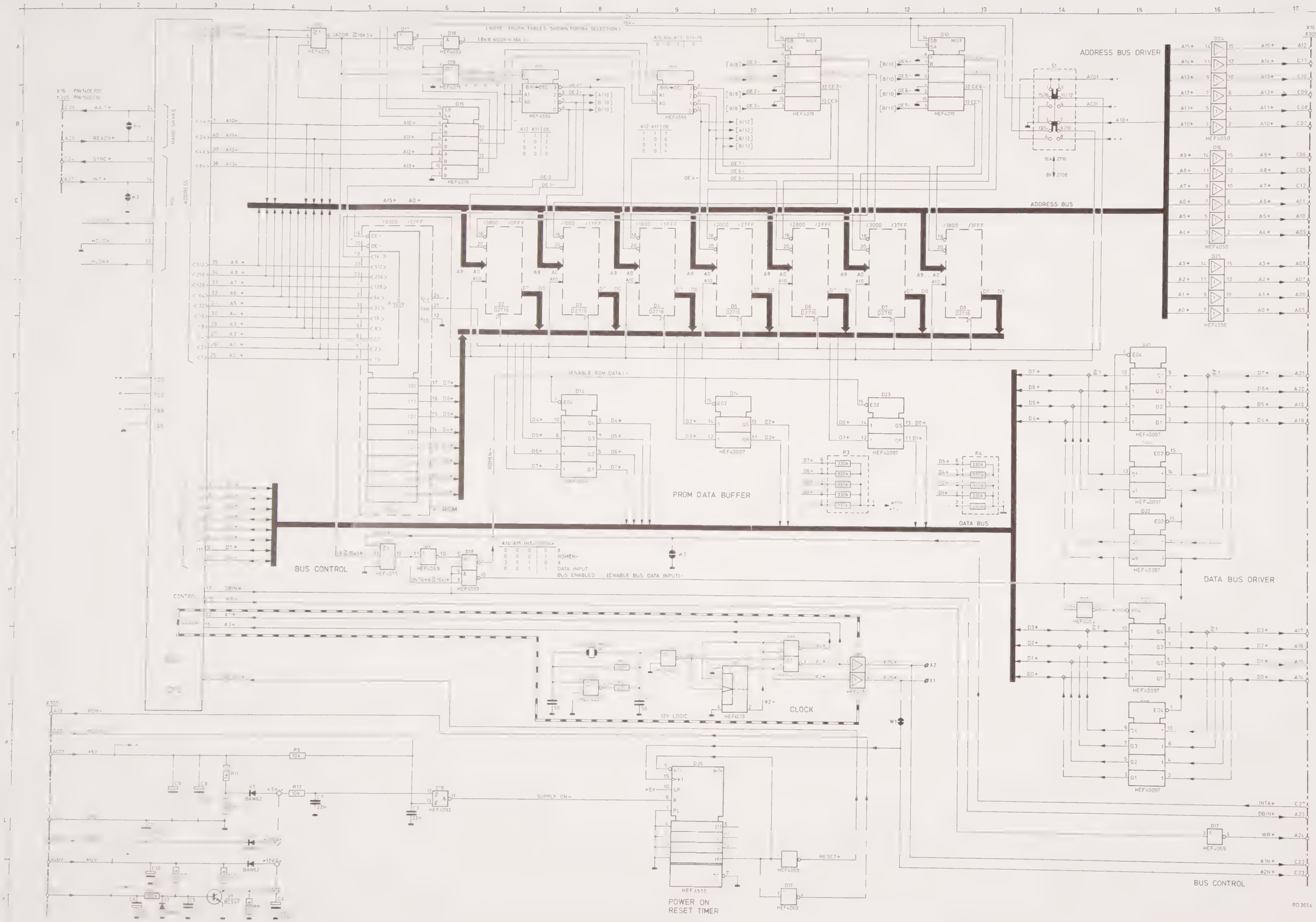


Fig. 4.3.1.2. CPU/ROM circuit diagram (universal)

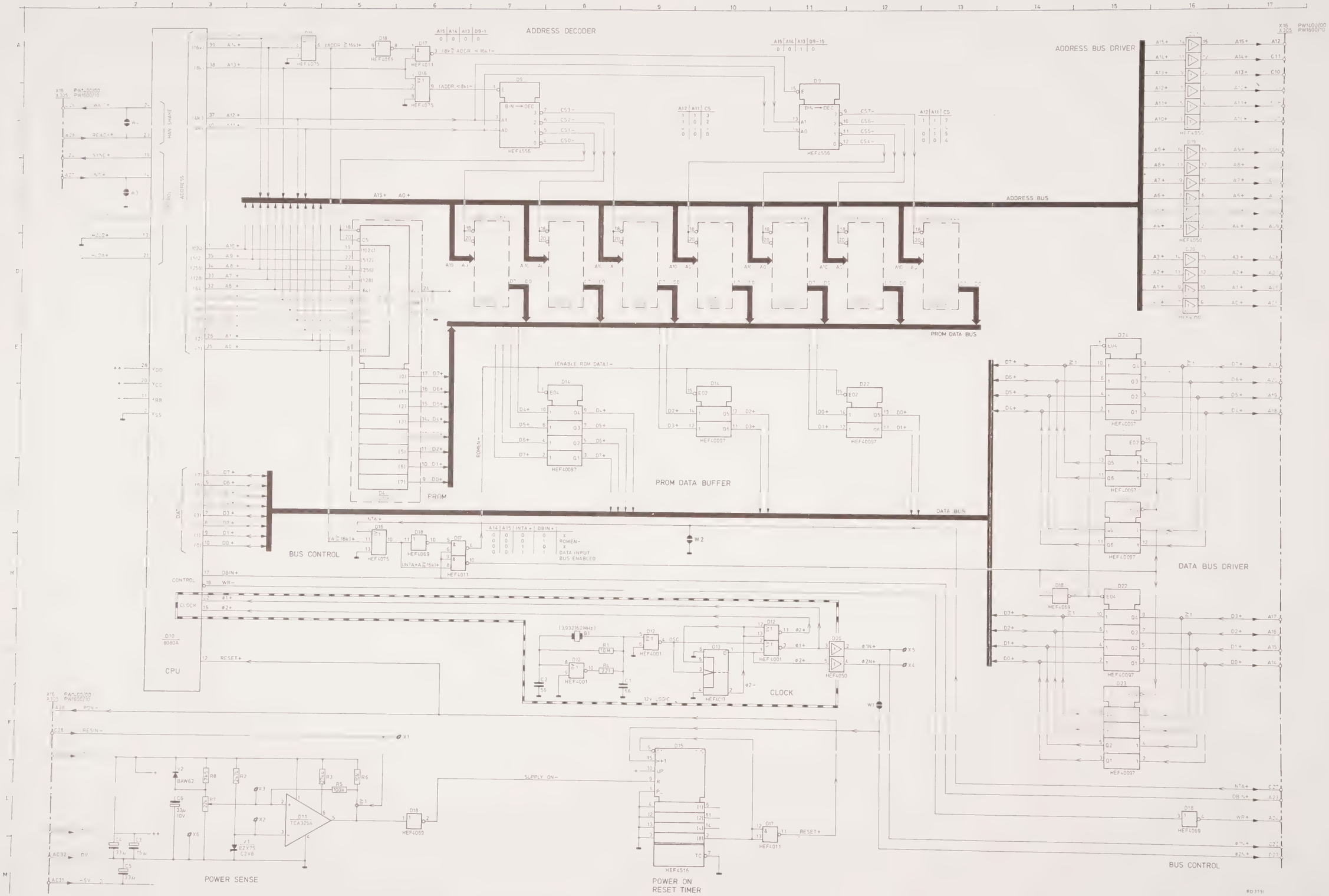


Fig. 4.3.1.3. CUP/ROM circuit diagram (non-switched)

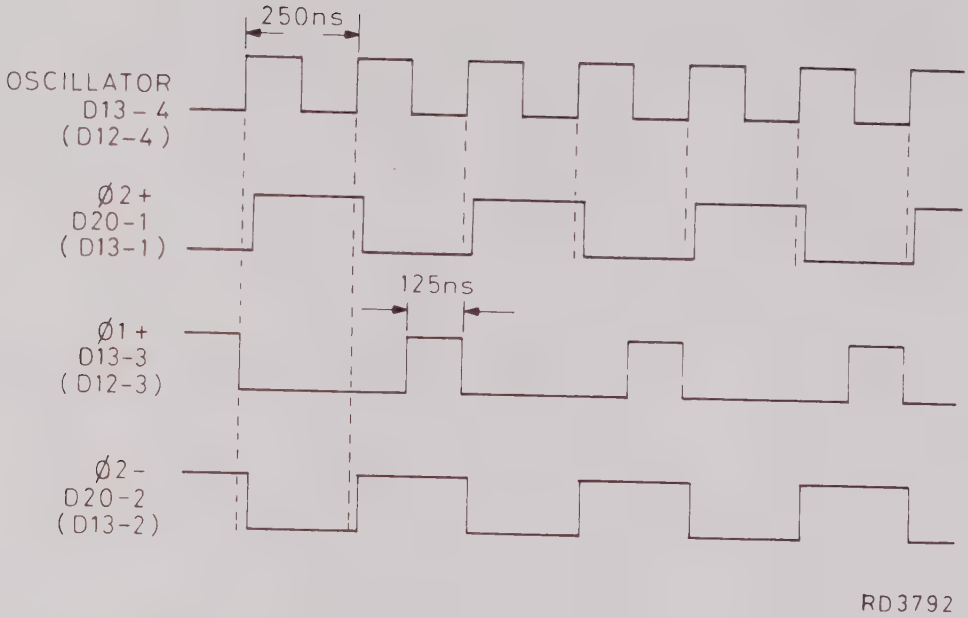


Fig. 4.3.1.4. Clock generator signals

4.3.2. Random access memory (see fig. 4.3.2.1. and 4.3.2.2.)

The RAM p.c.b. which is used in the system has a capacity of 2k (2048 8-bit words). The selection of a p.c.b. is made via a jumper setting on the p.c.b.
The organization of the memory p.c.b. is as follows: The RAM ic has a capacity of 256 words of 4 bits so two i.c.'s are used to built up an 8-bit word. The selection of a word is done via the address lines A0 up to A7, the signals coming from the CPU via the gates D17 and D19 (fig. 4.3.2.2. C/2).
The 2k of memory is divided into two parts of 1k and each 1k is formed from 4 times 256 words.
The selection of the upper and lower 1k is done with the signal CS1 and the selection of one of the groups of the 1k by the signal CS2–x.
The selection of the memory p.c.b. is done via the address lines A15, A13–A11, the signals being decoded by the BIN/DEC decoder D23 in the following way:

A15	A13	A12	A11
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1

W1	W2	W3	W4	W5	W6	W7	W8
1	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0
0	0	0	1	0	0	0	0
0	1	0	0	0	0	0	0

When the output of the decoder is "1" it can activate a memory p.c.b. when the relevant jumper is closes and address bit A14 = "1". This means that via the gate D18–6 (A/5) the signal "card selected" becomes true and enables the gates which generate via the address bit A10, signal CS1 as shown in the table:

Card selected	A10
1	0
1	1

D22–4	D22–3
1	0 lower 1k
0	1 upper 1k

The same signal "card selected" enables the gates which decode the address bits A9 and A8 to produce the signals CS2–x (see table).

Card selected	A9	A8
1	0	0
1	0	1
1	1	0
1	1	1

CS2–x			
0	1	2	3
1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

The combination of these signals CS1– and CS2–x enables the relevant RAM i.c.'s on the memory p.c.b.

Input/output selection

The microcomputer bus is connected via an input data and output data buffer D19, 24 and D20, 25 to the in and output lines of memory.
When the memory is selected and the signal WR (B/1) goes low the signals available on the input data bus are written into the memory.
When the signal WR is high the contents of the selected memory word is set on the output data bus and transfered to the data bus via D20 and D25 (F/15) when these gates are enabled. The enable input signal becomes true when signal DBIN+ is "1" and INTA+ is "0" (A/12).

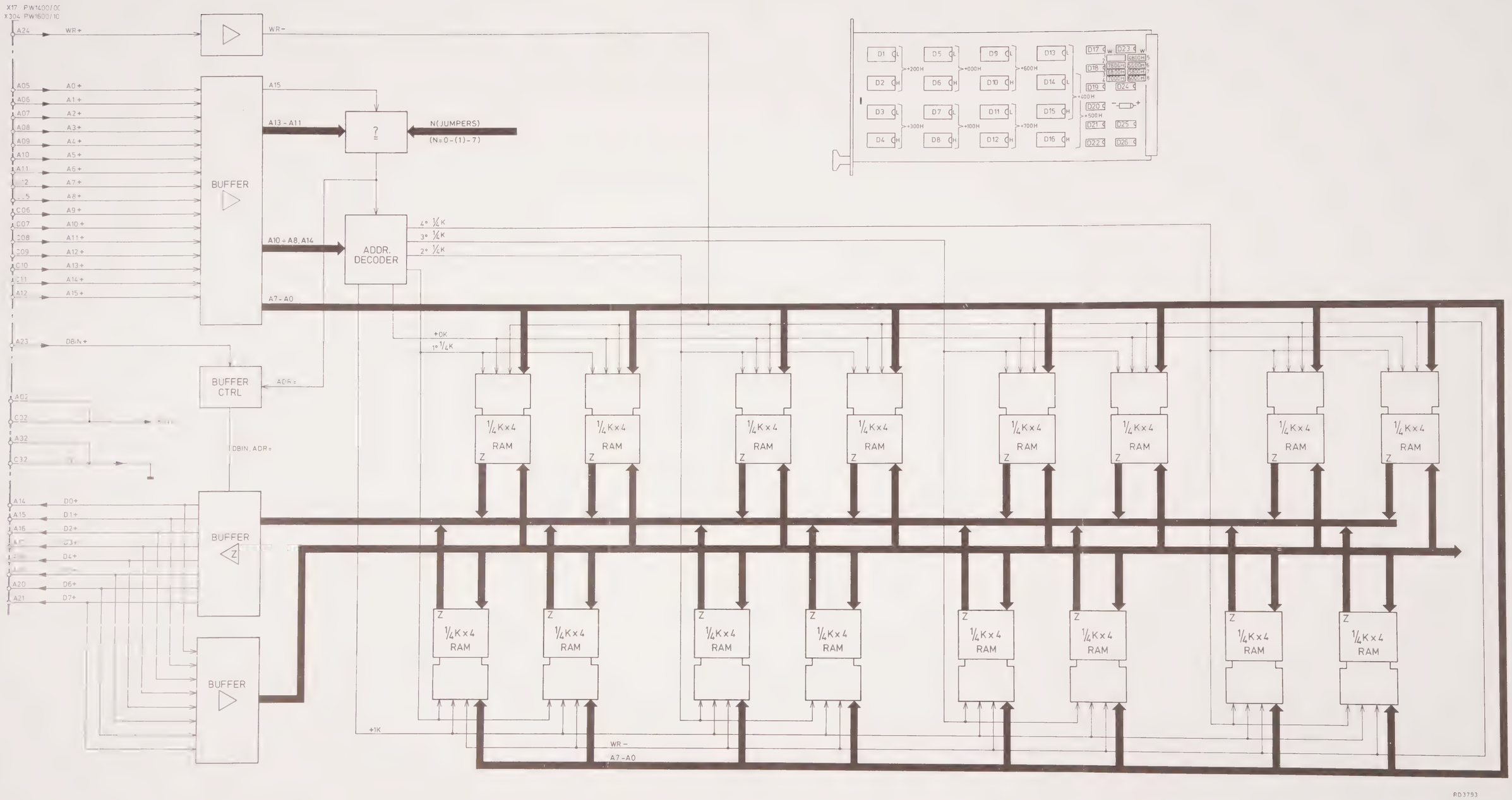


Fig. 4.3.2.1. Random Access Memory Blockdiagram

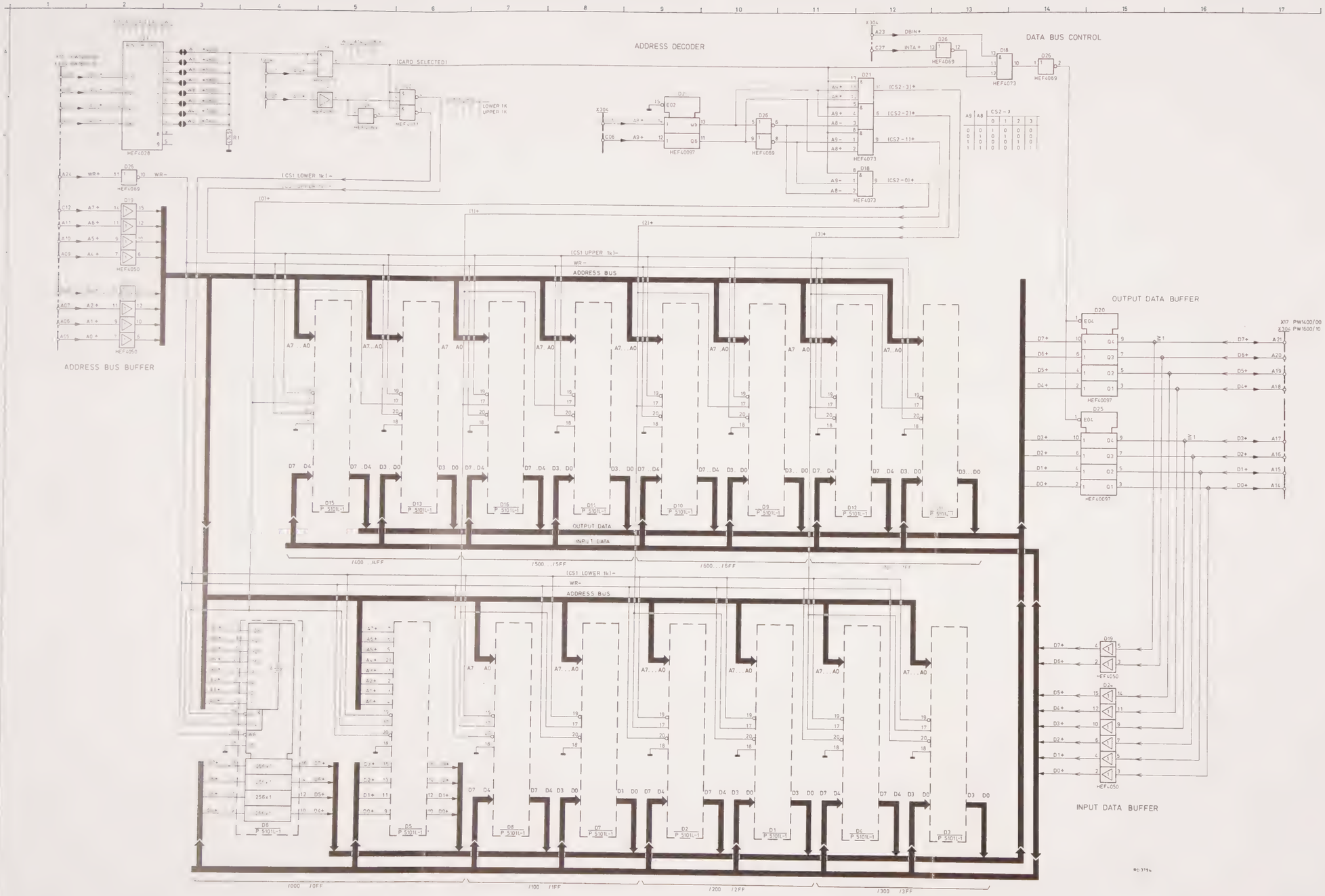


Fig. 4.3.2.2. Random Acces Memory circuit diagram

4.3.3. Serial I/O interface

4.3.3.1. *Introduction*

The function of the serial interface is to provide a means by which another device such as a VDU or a computer can be connected to the microprocessor system busses.

One serial interface pcb (Interface 1) is delivered as standard in the PW1400/00 mounted in position A20. This interface can carry out both input and output functions simultaneously (i.e. in full duplex) and can be adapted by means of switches so that a wide variety of peripherals can be connected to it.

A second interface pcb (Interface 2) may be mounted in position A19. This pcb is available as an option under the number PW1715/00, and in this position (A19) it can only be used to provide output signals.

These two interfaces are identical and interchangeable provided that the appropriate switch and jumper settings are correctly set to match the peripheral which is to be connected.

> NOTE
>
> Most peripherals also have switches and/or jumpers which must be correctly set before the peripheral can be connected to the interface.

The serial interface offers the following possibilities:

(a) V24 interfacing to EIA specification RS232-C.

(b) 4-wire current loop interfacing with 20 mA internal current source (i.e. current source on interface).

(c) 4-wire current loop interfacing with 20 mA external current source (i.e. current source in peripheral).

4.3.3.2. *(a) Input/Output connector and null modem*

Connection to a peripheral is made via an AMP connector (X20B) mounted on the serial interface pcb, and a second connector X104, identically wired, and mounted on the rear panel of the PW1400/00 (see fig. 4.3.3.1.).

To enable the PW1400/00 to be connected to a remote terminal via two modems and a telephone line, the connector is wired in the configuration of a terminal. This means that when it is required to connect a peripheral which is also wired as a terminal, direct pin-to-pin wiring is not possible and a null modem must be used.

The null modem is wired as shown in fig. 4.3.3.2. It consists of a small printed circuit board with two 25-pin female connectors, one mounted on the board and one attached by a short length of cable. Some of the interconnections on the board are made via soldering pins to enable modifications to be made if necessary, and the connections for "protective ground" and "signal ground" are provided with jumpers.

The null modem is also so wired that the signal "clear to send" for both the PW1400/00 and the peripheral is generated by its own "request to send" signal. The PW1400/00 signal "clear to send" also results in "data carrier detected" for the peripheral, and vice versa.

Wiring is also present in the spectrometer to enable a second interface to be fitted in position A19. This consists of an AMP connector X19B connected to X105 on the rear panel of the spectrometer.

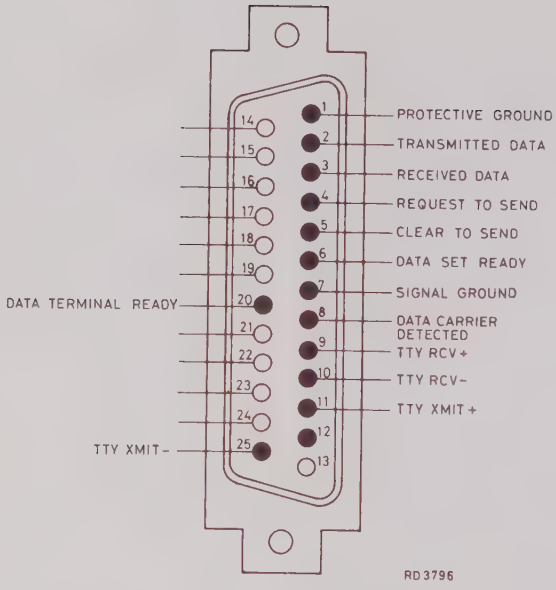


Fig. 4.3.3.1. I/O Connector

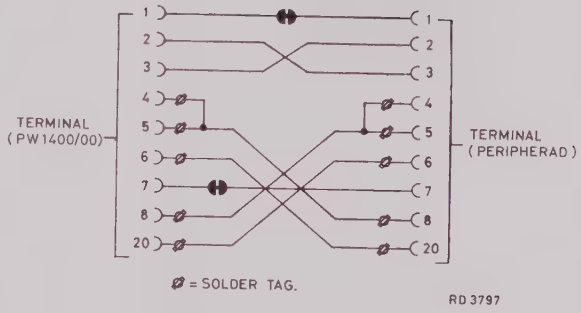


Fig. 4.3.3.2. Null modem

- **Functions of signals for connectors X104 and X105**

Pin	Mnemonic	Signal name	Direction	Description	
1	PROT GND (101)	Protective ground	E*– P**	Connected to PW1400 body	V24
2	TXD (103)	Transmitted data	E ← P	Data from PW1400	
3	RXD* (104)	Received data	E → P	Data to PW1400	
4	RTS (105)	Request to send	E ← P	"1" while PW1400 is ready to operate	
5	CTS (106)	Clear to send	E → P	PW1400 temporarily not allowed to send data while CTS = 0	
6	DSR (107)	Data set ready	E → P	Data is effective when DSR = "1"	
7	SGND (102)	Signal ground	E – P	Connected to signal ground	
8	DCD (109)	Data Carrier detected	E → P	Connection is established if DCD = "1"	
20	DTR (108.2)	Data Terminal Ready	E ← P	"1" while PW1400 is ready to operate	
9	TTY RCV+	Teletype receive +	E → P	Positive receive line	Current loop
10	TTY RCV –	Teletype receive –	E → P	Negative receive line	
11	TTY XMT+	Teletype transmit +	E ← P	Positive transmit line	
25	TTY XMT –	Teletype transmit –	E ← P	Negative transmit line	

E* = External controller
P** = PW1400

Note that the lines 4 and 5 are interconnected in the null modem. This means that when the PW1400/00 is operational and it generates RTS = 1, this also results in CTS = 1.

(b) Handshake procedure

When power is connected to the PW1400/00 the microcomputer generates DTR = 1; via the null modem the peripheral sees this as DSR (the PDP11 minicomputer does not recognize DSR, which it interprets as "microcomputer power on". Therefore, for the PDP11 the signal DCD is used). When power is connected the microcomputer also sets RTS = 1, which the peripheral sees as DCD. The signal RTS is normally answered with CTS, so in the null modem, RTS and CTS are interconnected. Before each character is transmitted, the microcomputer checks to see that signal DSR is true, or that the signal DCD is present. This check is made by the software.

The USART in the serial interface will not transmit a character if the signal CTS is not present. If, for any reason, the peripheral temporarily cannot accept a character, it makes DTR = 0. The microcomputer in the PW1400/00 sees this as DSR = 0, which causes it to wait (since the signal DSR is not used in the PDP11, the PW1400/00 cannot indicate to the computer that it is temporarily unable to accept characters).

The software for the PDP11 minicomputer checks if the signal DCD is present before each character is sent. If this signal is not detected it prints the message SPECTROMETER OFF. The software also checks if the signal CTS is present — if not, the computer waits.

4.3.3.3. *Functional description*

At the heart of the interface is a programmable Universal Asynchronous Receiver-Transmitter (USART). This i.c. receives from (and sends to) the microcomputer information in 8-bit parallel format and transmits to (and receives from) a peripheral, information in 7-bit or 8-bit serial format (see fig. 4.3.3.3., 4.3.3.4. and 4.3.3.5.).

The timing of the input/output 8-bit parallel signals and the control signals can also be seen by reference to section 4.3.4. Bus Interface.

The USART is programmed by the microprocessor by means of control words. Whenever the signals C/D = 1 and RD- = 1 the USART interprets a word on the data bus as a control word. The first control word to be received is always interpreted as a mode instruction, and all subsequent control words as command instructions.

A typical data block, after a reset has been given, might be:

C/D- = 1	MODE INSTRUCTION
C/D- = 1	COMMAND INSTRUCTION
C/D- = 0	FIRST DATA BYTE
C/D- = 0	SECOND DATA BYTE
	ETC.

The function of the various control signals for the USART is as follows:

CS-	C/D-	RD-	WR-	FUNCTION
0	0	0	1	Data character read from USART
0	0	1	0	Data character written into USART
0	1	0	1	Status information read from USART
0	1	1	0	Control word written into USART
1	x	x	x	USART not selected

The data word to be transmitted appears on the data bus D0-D7 in 8-bit parallel format, and is applied to the buffers D8 and D10 (fig. 4.3.3.3.H/8). When the buffers are enabled by WR- = 0 and bit A0 + = 0 (C/D = 0) the data word is written into the USART. To each data character the USART automatically adds a start bit (low level) and the programmed number of stop bits. Also it inserts an even or add parity bit prior to the first stop bit as defined.

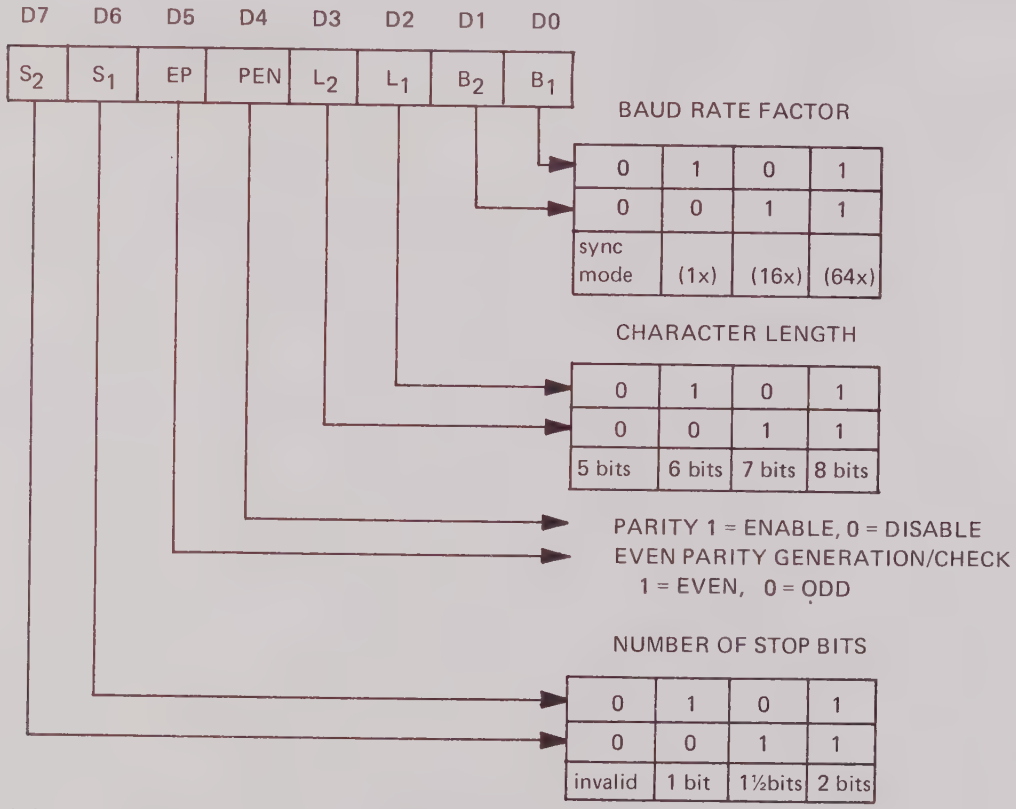
4.3.3.3.1. Communication with peripheral (asynchronous mode)

The USART is programmed by loading two control words which provide it with a complete functional definition. These control words perform the functions:

1. Mode instruction;
2. Command instruction.

4.3.3.3.2. Mode instruction

This word defines the general operational characteristics of the USART, and always follows a RESET operation. Once a mode instruction has been written into the USART, a command instruction may be inserted.

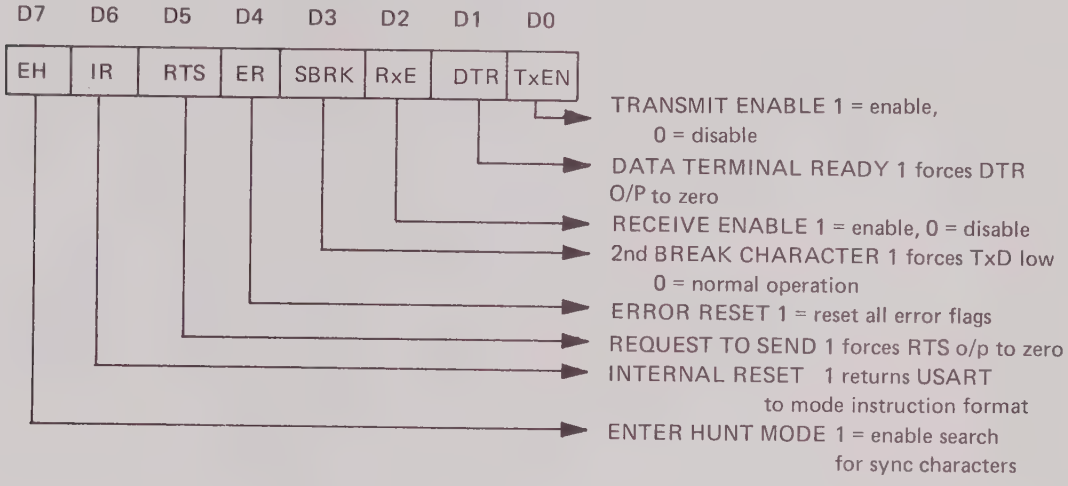

D7 D6 D5 D4 D3 D2 D1 D0
S2 S1 EP PEN L2 L1 B2 B1
BAUD RATE FACTOR
0 1 0 1
0 0 1 1
sync mode (1x) (16x) (64x)
CHARACTER LENGTH
0 1 0 1
0 0 1 1
5 bits 6 bits 7 bits 8 bits
PARITY 1 = ENABLE, 0 = DISABLE
EVEN PARITY GENERATION/CHECK
1 = EVEN, 0 = ODD
NUMBER OF STOP BITS
0 1 0 1
0 0 1 1
invalid 1 bit 1½bits 2 bits

The mode instruction word is formed by the switches S7 and S8 and is read by the microprocessor when the parameter control buffers D7-D11 are enabled by the signals A0, A1, DBIN, and CS1. It is then written into the USART by the microprocessor.

4.3.3.3.3. Command instruction

Once the functional definition of the USART has been programmed by the mode instruction, it is ready to be used for data communication. The command instruction controls the actual operation of the selected format.

Once the mode instruction has been written into the USART, all further "control writes" (C/D = 1) will load the command instruction. A reset operation will return the USART to the mode instruction format.


D7 D6 D5 D4 D3 D2 D1 D0
EH IR RTS ER SBRK RxE DTR TxEN
TRANSMIT ENABLE 1 = enable, 0 = disable
DATA TERMINAL READY 1 forces DTR O/P to zero
RECEIVE ENABLE 1 = enable, 0 = disable
2nd BREAK CHARACTER 1 forces TxD low 0 = normal operation
ERROR RESET 1 = reset all error flags
REQUEST TO SEND 1 forces RTS o/p to zero
INTERNAL RESET 1 returns USART to mode instruction format
ENTER HUNT MODE 1 = enable search for sync characters

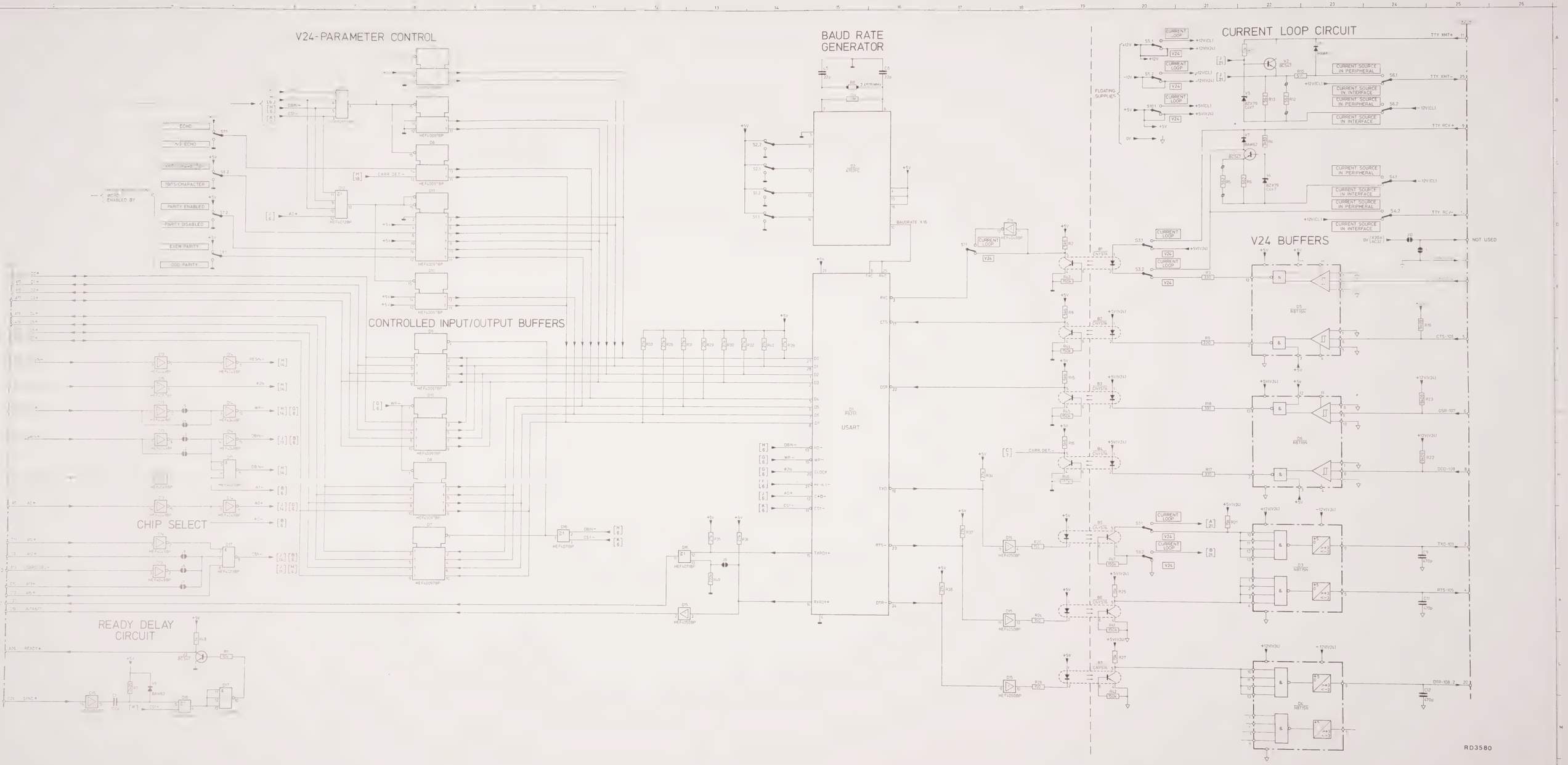
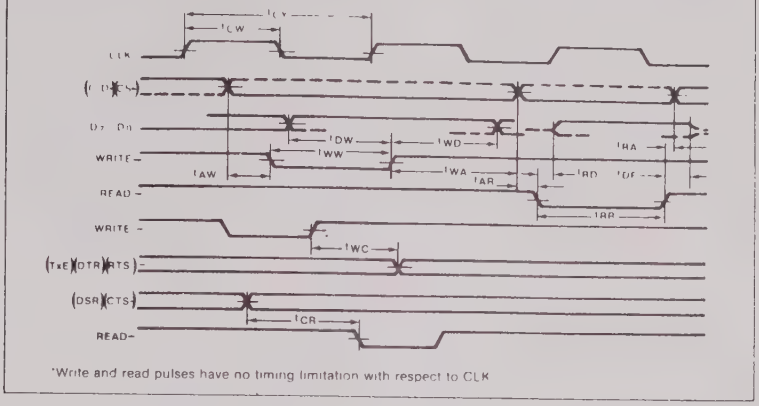


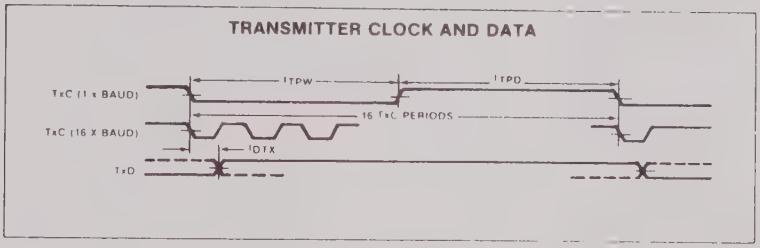
Fig. 4.3.3.3. Circuit diagram

TIMING WAVEFORMS

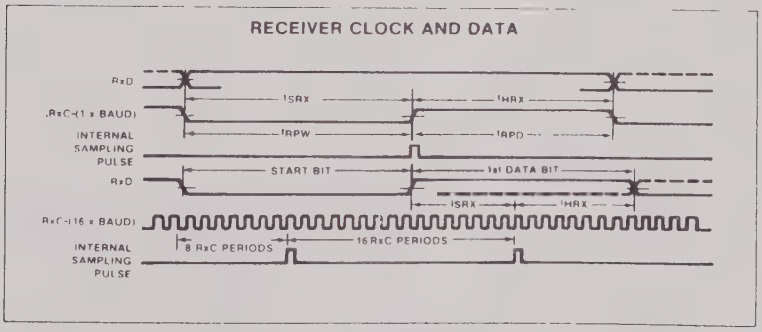
READ AND WRITE TIMING



TRANSMITTER CLOCK AND DATA



RECEIVER CLOCK AND DATA



TxRDY AND RxRDY TIMING (ASYNC MODE)

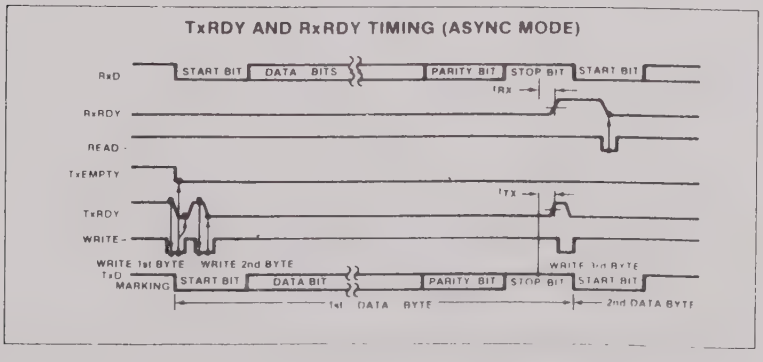


Fig. 4.3.3.4. Timing waveforms

4.3.3.3.4. Transmission to peripheral

Whenever a data character is sent by the microcomputer the USART automatically adds a start bit (low level) and the programmed number of stop bits. Also an even or odd parity bit is inserted prior to the stop bit (s), as defined by the mode instruction. The character is then transmitted as a serial data stream on the TxD output.

The serial data is shifted out on the falling edge of TxC– at a rate equal at 1, 1/16, on 1/64 that of TxC–, as defined by the mode instruction.

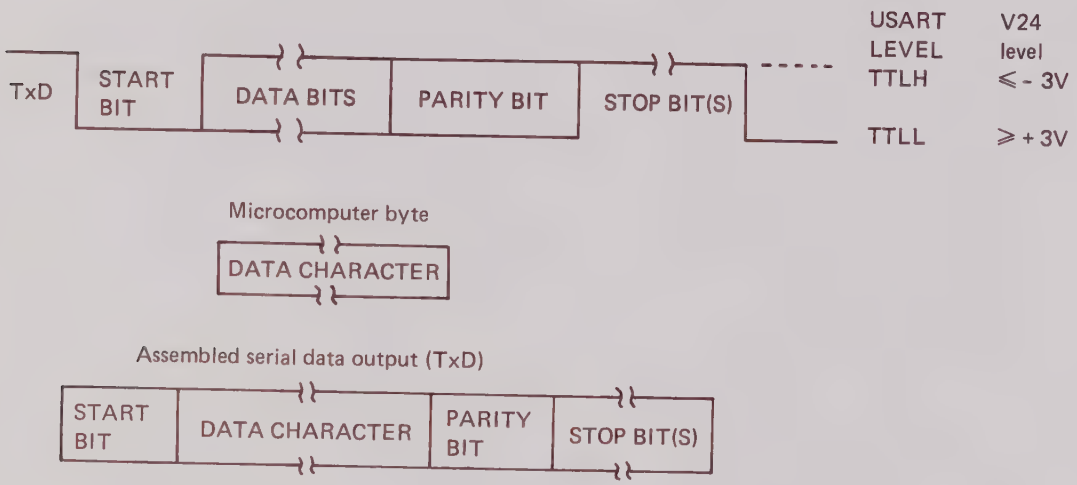


Fig. 4.3.3.3.4. Transmission format.

The serial data is first routed via an optocoupler which provides galvanic isolation of the peripheral when current loop with an external current source is used. It is then presented to the peripheral either in V24 or current loop form, selected by switches S3, S5, and S9-11.
In the current loop mode a further selection can be made depending on whether the current source is the peripheral or in the interface.
This selection is made with the switches S4 and S6.

4.3.3.3.5. Transmission from peripheral (Asynchronous mode)

The RxD line is normally high. A falling edge on this line triggers the beginning of a start bit, and the bit counter starts counting. The bit counter locates the centres of the data bits, the parity bit (if present) and the stop bits. If a parity error occurs the parity error flag is set.

Data and parity bits are sampled on the RxD input with the rising edge of RxC. If a low level is detected as the stop bit the framing error flag will be set.

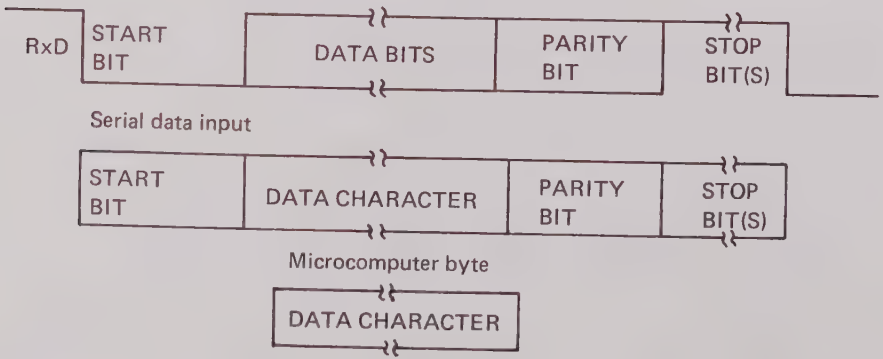


Fig. 4.3.3.3.5. Receive format.

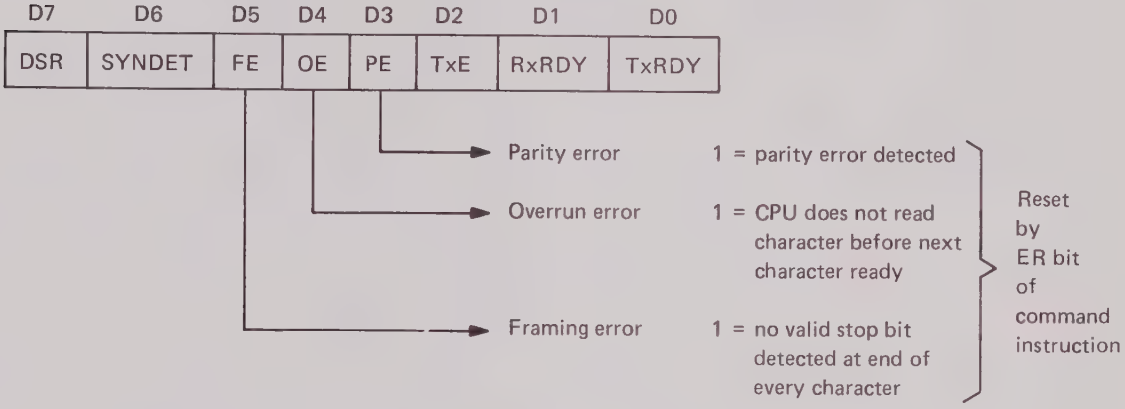
The character is then loaded into the parallel I/O buffer of the USART and signal RxDY = 1 to indicate to the microprocessor that a character is ready to be fetched.

If a previous character has not been fetched by the microprocessor, the character now ready to be fetched replaces it in the I/O buffer and the previous character will then be lost. If this happens the overrun flag will be set.

The occurrence of any of these errors will not stop the operation of the USART. All the error flags will be reset by a command instruction.

4.3.3.3.6. Status read (USART)

The status of the USART can be read by the microprocessor so that the setting of error flags and other conditions can be checked. This occurs when the microprocessor issues a normal read command while C/D (bit A0) = 1 and bit A1 = 0.



The rest of the bits in the status word have the same definitions as those of the I/O signals of the USART.

4.3.3.3.7. Status read (serial interface)

The microcomputer can read two status words from the serial interface pcb. One word is used by the microcomputer to form the mode command for the USART, and is read when address bits A0 = 0 and A1= 1.

D7	D6		D3		D1	D0
1	1	0 = odd parity 1 = even parity	0 = parity disable 1 = parity enable	1	0 = 7 bits/char. 1 = 8 bits/char.	1	0

The other status word is read by the microcomputer when address bits A0 = 1 and A1 = 1 and is as follows:

D7	D6	D5	D4	D3	D2	D1	D0
0 = DCD on 1 = DCD off	x	x	0 = no echo 1 = echo	0	0	0	1

4.3.3.4. *Serial data transmission format*

The serial data transmission format conforms to EIA specification RS 232-C, in which specification a full definition will be found.

Interchange voltages:

Signal	Electrical state	
	⩽ − 3V or current	⩾ + 3V or no current
Data TD and RD	STOP or logic "1"	START or logic "0"
Control	OFF	ON

NOTES

1. Data transmission occurs simultaneously with the positive-going edge of the clock pulse.
2. Signals with levels between − 3V and + 3V are indeterminate.

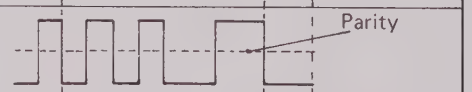
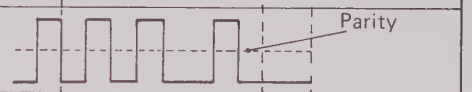
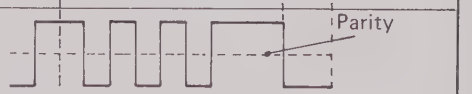
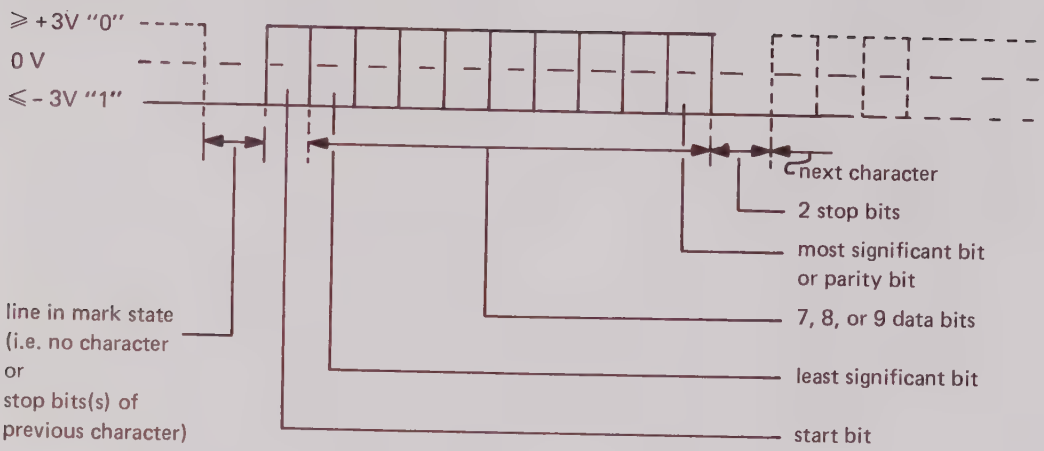
No. of bits	Parity	Character	ASCII code Hexadec.	Binary representation	Binary reversed + parity	Transmission format
7	NO	4	/34	0 0 1 1 0 1 0 0	0 0 1 0 1 1 0	
7	EVEN	4	/34	0 0 1 1 0 1 0 0	0 0 1 0 1 1 0 Parity bit 1	
		3	/33	0 0 1 1 0 0 1 1	1 1 0 0 1 1 0 Parity bit 0	
		5	/35	0 0 1 1 0 1 0 1	1 0 1 0 1 1 0 Parity bit 0	
7	ODD	4	/34	0 0 1 1 0 1 0 0	0 0 1 0 1 1 0 Parity bit 0	
		3	/33	0 0 1 1 0 0 1 1	1 1 0 0 1 1 0 Parity bit 1	
		5	/35	0 0 1 1 0 1 0 1	1 0 1 0 1 1 0 Parity bit 1	
8	NO	3	/33	0 0 1 1 0 0 1 1	1 1 0 0 1 1 0 0	
		4	/34	0 0 1 1 0 1 0 0	0 0 1 0 1 1 0 0	
		5	/35	0 0 1 1 0 1 0 1	1 0 1 0 1 1 0 0	
8	EVEN	*	/2A	0 0 1 0 1 0 1 0	0 1 0 1 0 1 0 0 Parity bit 1	
8	ODD	*	/2A	0 0 1 0 1 0 1 0	0 1 0 1 0 1 0 0 Parity bit 0	

Fig. 4.3.3.5. Typical serial data formats

Transmission format of ASCII characters:



NOTES

1. The first data bit after the start bit is the least significant bit of the ASCII code.
2. A logical "1" in the ASCII code corresponds to a RS232-C logical "1" (i.e. ≤ - 3V) on the transmission line.
3. A parity bit (if transmitted) is the bit before the stop bit(s).
4. For the PC1409 teletype transmitted characters always consist of 7 bits plus 1 parity bit (even parity) irrespective of the position of the switch PARITY ON/OFF.
5. In the PC1409 received characters are tested for even parity if the parity pushbutton is in the position "PARITY" (the 8th data bit = parity bit).

Interpretation of parity

Bits/ character	Parity	Odd/even	No. of bits on transmission line	Remarks
7	disabled	—	7	If 2 stop bits are used, this is equal to 8 data bits with the 8th bit = 1 and 1 stop bit
7	enabled	even	8	8th bit = parity bit
7	enabled	odd	8	8th bit = parity bit
8	disabled	—	8	8th bit = zero (software programmed)
8	enabled	even	9	8th bit = zero (software programmed) 9th bit = parity bit
8	enabled	odd	9	8th bit = zero (software programmed) 9th bit = parity bit

All characters received by the interface from a peripheral are tested for framing (i.e. number of bits) and for parity (if enabled). The software clears the 8th data bit before it is used.

4.3.3.5. *Jumpers and switch settings*

By means of jumpers and switches the serial interface can be adapted to work with a wide variety of peripherals (see fig. 4.3.3.5.1.).

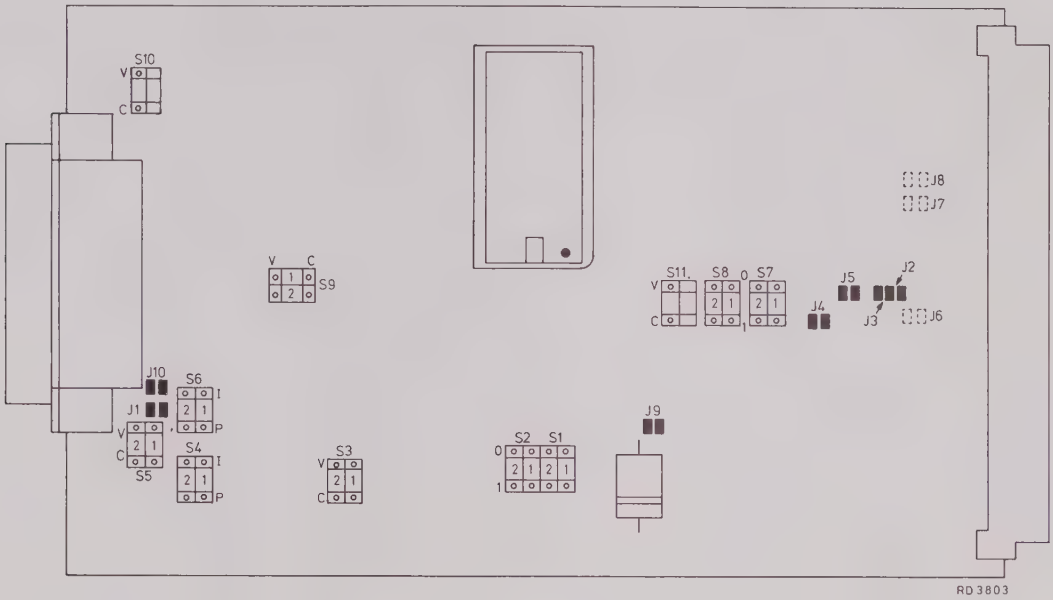


Fig. 4.3.3.5.1. Jumpers and switches

Function		Action
Grounding	Connection between protective ground (101) and signal ground (102)	Close J1
	Connection between protective ground (101) and logic 0V	Close J10
PCB address	I/O interface No. 1, address /9xxx	Open J6 Open J7 Close J8
	I/O interface No. 2, address /Axxx	Open J6 Close J7 Open J8
Not used in PW1400/00	Addressing via "card select"	Close J6 Open J7 Open J8
PW1400/00 application	Polarity of WR and RD (DBIN) signals: Active high	Close J2 Close J4 Open J3 Open J5
Not used in PW1400/00	Active low	Open J2 Open J4 Close J3 Close J5

Selection of operating mode (current loop source in interface or peripheral), or V24 (RS232C).

Mode	S3– 1+2	S4– 1+2	S5– 1+2	S6– 1+2	S9– 1+2	S10	S11
V24	V	X	V	X	V	V	V
Current loop (source in interface)	C	I	C	I	C	C	C
Current loop (source in peripheral)	C	P	C	P	C	C	C

Baude rate selection

Baude rate	S2-2	S2-1	S1-2	S1-1
MUX	0	0	0	0
MUX	0	0	0	1
50	0	0	1	0
75	0	0	1	1
110	1	1	1	1
134,5	0	1	0	0
150	1	1	1	0
200	0	1	0	1
300	1	1	0	1
600	0	1	1	0
1200	1	0	1	1
1800	1	0	1	0
2400 or	0	1	1	1
2400 or	1	1	0	0
4800	1	0	0	1
9600	1	0	0	0

Echo character

Echo S7-1 = 1
No Echo S7-1 = 0

Parity

None S7-2 = 0 S8-1 = 0 or 1
Even parity S7-2 = 1 S8-1 = 1
Odd parity S7-2 = 1 S8-1 = 0

Number of bits per character (excluding parity) 7: S8-2 = 0
8: S8-2 = 1

Connection between INTR6 and INTR7 Close J9

X = don't care
C = current loop
V = V24 (RS232C)
I = current source in PW1400/00 interface
P = current source in peripheral

Use in current loop mode

The PW1400/00 software makes use of the handshake procedure in all interface configurations. This means that in current loop mode the handshake signals must also be present. This can be achieved by ensuring that the +5V (V24) and −12V (V24) power supplies are always present on the V24 buffers.

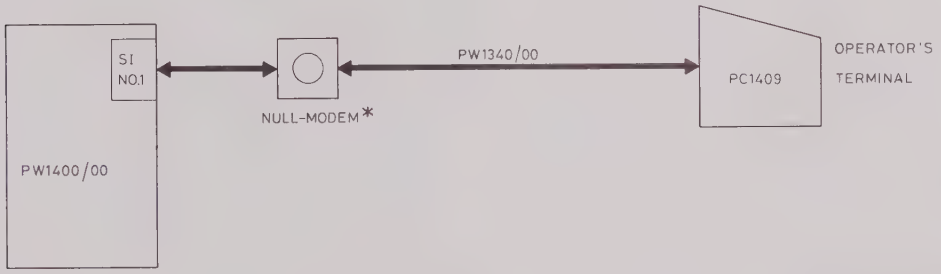
For current loop applications interconnect the supply side and the V24 contact of the switches S5.2 [Fig. 4.3.3.3. A/20] and S10.1 [B/20].

4.3.3.6. *Connection of peripherals and computers*

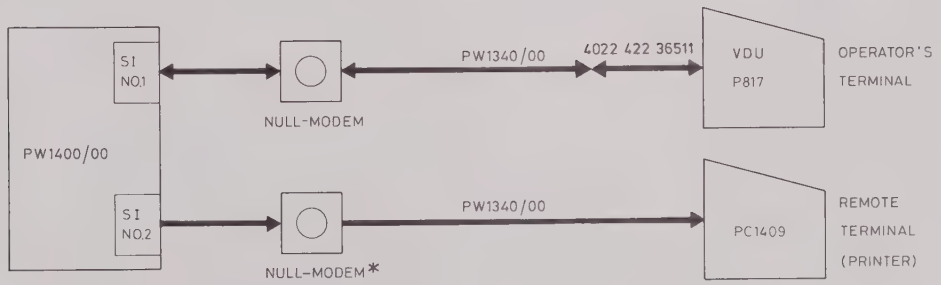
This section includes information on the connection of several commonly used peripherals and computers. Circuit diagrams of the interface pcb's in these peripherals are given where appropriate, together with the necessary jumper and/or switch settings.

Peripheral equipment ordered and supplied with a PW1400/00 system is usually provided with separate manuals. This section supplements this information, partly by including material reproduced from or based on, manuals supplied by the manufacturers of the peripherals, and partly by including additional information (see fig. 4.3.3.6.).

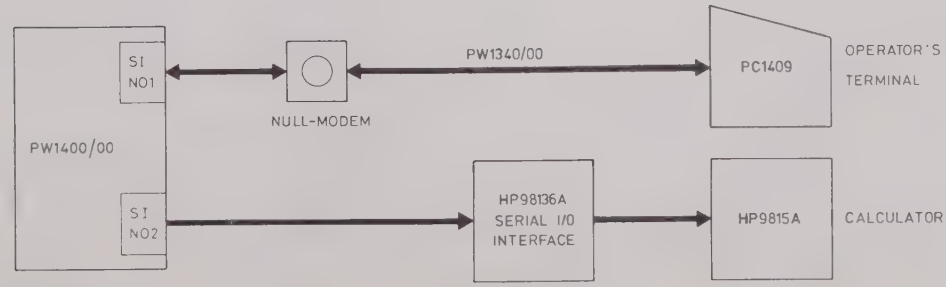
1



2

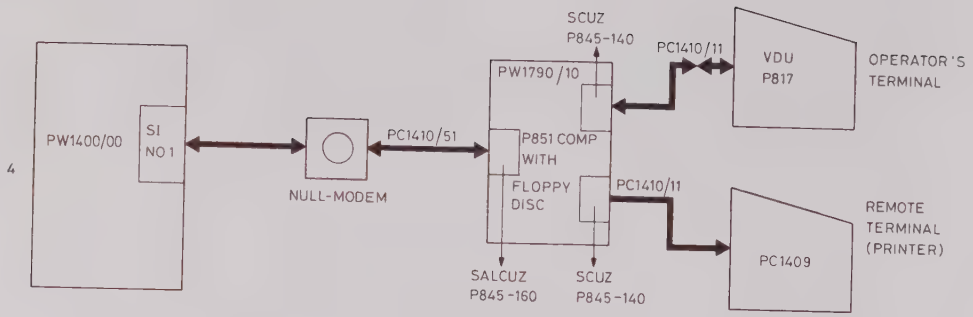


3



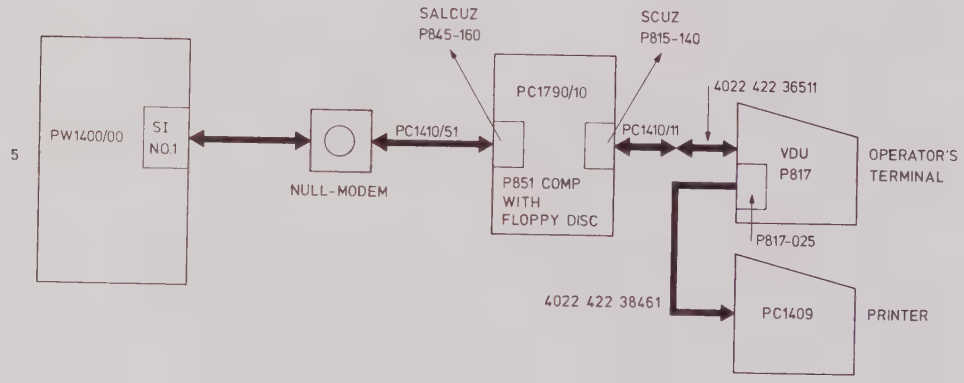
RD3698

4



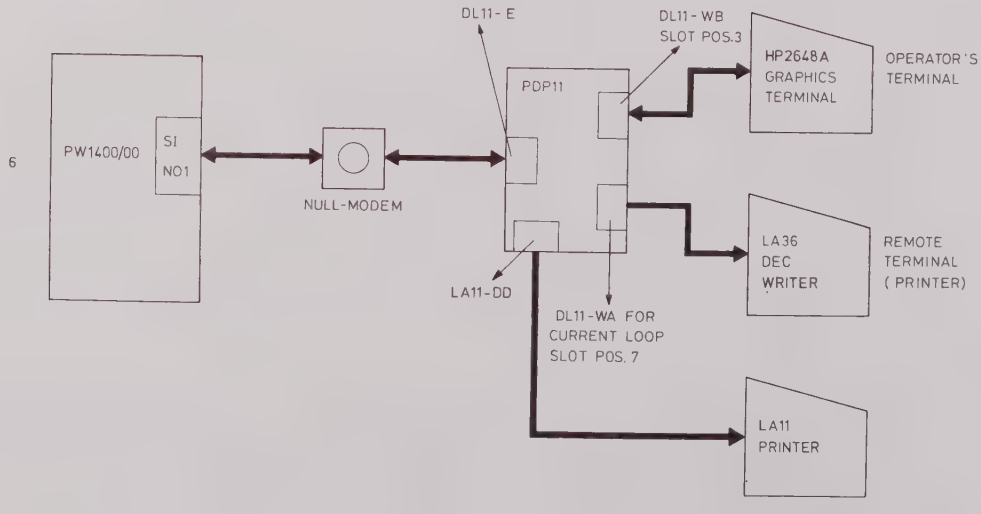
RD3696

5



RD3697

6



RD3695

Fig.4.3.3.6. Serial Interface Configurations

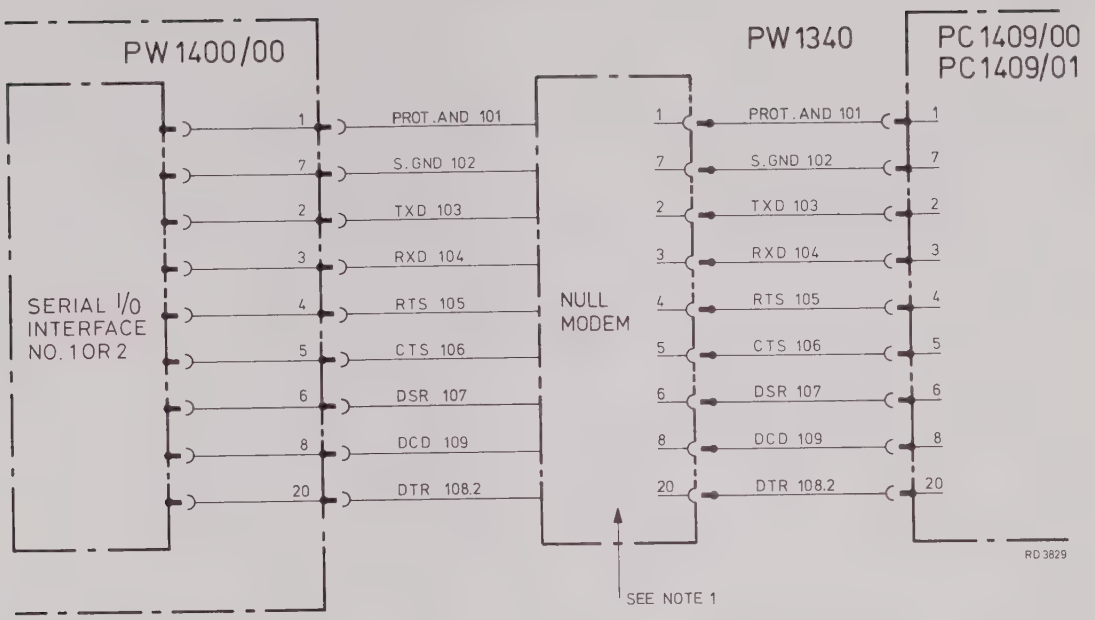
4.3.3.6.1. Teleprinter type PC1409/00 and /01 (see fig. 4.3.3.6.1.1. – fig. 4.3.3.6.1.3.)

The PC1409/00 is a particular version of the Teletype KSR43 with a special interface. This interface has facilities to enable it to handle data in V24 format (to EIA specification RS232-C) and in 20 mA current loop format (with the current source either in the interface or in the teleprinter).
The PC1409/01 is similar to the PC1409/00 but has a different interface (see fig. 4.3.3.6.1.2.).

All connections are made via a 25-pole connector as follows:

Pin	Signal name			Pin	Signal name	
1	PROT GND	101		13		
2	TXD	103		14		
3	RXD	104		15	RCV–	
4	See note			16	RCV+	
5	CTS	106	V24	17	PS NEG (––)	Current loop
6	DSR	107		18		
7	S GND	102		19		
8	DCD	109		20	DTR 108.2 (V24)	
9				21	XMIT–	
10				22	XMIT+	
11				23		Current loop
12				24	PS POS (++)	
				25		

The PC1409/00 and /01 are intended to be connected to a 220 V mains supply. In spite of this they may still be fitted with internal labels indicating that a supply of 115 V ac is required. These indications, and those given in the handbook supplied with the teleprinter do not apply to the PC1409/00 or the PC1409/01.



Data Transfer Adjustment

Adjustment	PC1409/01	Serial Interface see fig. 4.3.3.5.1.
	Not adjustable	
V24		S3-1 = V S3-2 = V S4-1 = X S4-2 = X S5-1 = V S5-2 = V S6-1 = X S6-2 = X S9-1 = V S9-2 = V S10-1 = V S11-1 = V

(X = don't care)

Data Format and Baud Rate

Adjustment	PC1409/01	Serial Interface
300 Baud	Key 30CPS	S1-1 = 1 S1-2 = 0 S2-1 = 1 S2-2 = 1
110 Baud	Key 10CPS	S1-1 = 1 S1-2 = 1 S2-1 = 1 S2-2 = 1
8 bits/char. No parity check	Key Parity Check off	S7-2 = 0 S8-1 = X S8-2 = 1
Echo PC1409/01 on line	Key FDX Key Data	S7-1 = 1

Interface address	Interface No.1 (address 9xxx)	Interface No.2 (address Axxx)
	J6 = open	J6 = open
	J7 = open	J7 = closed
	J8 = closed	J8 = open

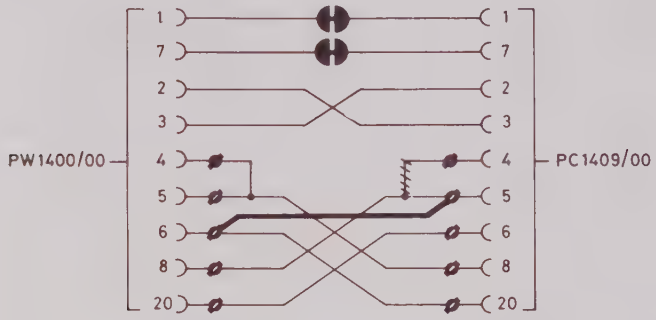
Interface used with 8080ACPU	J2 = closed J3 = open J4 = closed J5 = open
Interrupt	J9 = closed
Connection PROT.GND to S.GND	J1 = closed
Connection PROT.GND to 0 Volts	J10 = closed

Fig. 4.3.3.6.1.1. Connection of PC1409/00 and PC1409/01 in V24 mode.

Note 1

The PC1409/00 has been supplied in four different versions, each version requiring different connection treatment as follows:

1. Version with all pins present in the connecting plug. This version has incorrect timing. If it is to be connected to the PW1400/00, modify the null modem as follows:



   In this version the signal RTS has incorrect timing and cannot be used. Thus the PW1400/00 signals DSR and DCD and the PC1409/00 signal CTS are simulated by the PC1409/00 signal DTR. This situation is achieved by interconnections in the null modem.

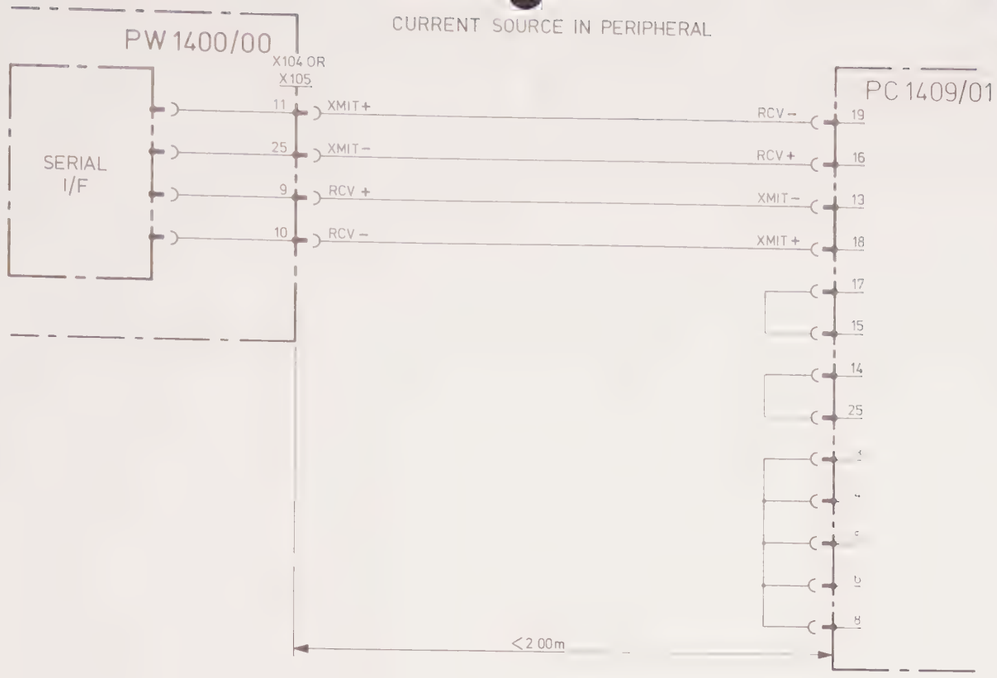
2. Version with a number of pins absent from the connecting block. This version has correct timing and can be connected without modifications to the null modem.

3. Version with all pins present in the connecting plug and having one of the following serial numbers:

85910	86300	86348
86004	86314	88508
86019	86320	88525
86044	86328	88528
86075	86336	88543
86165	86338	88546
86261	86347	88554

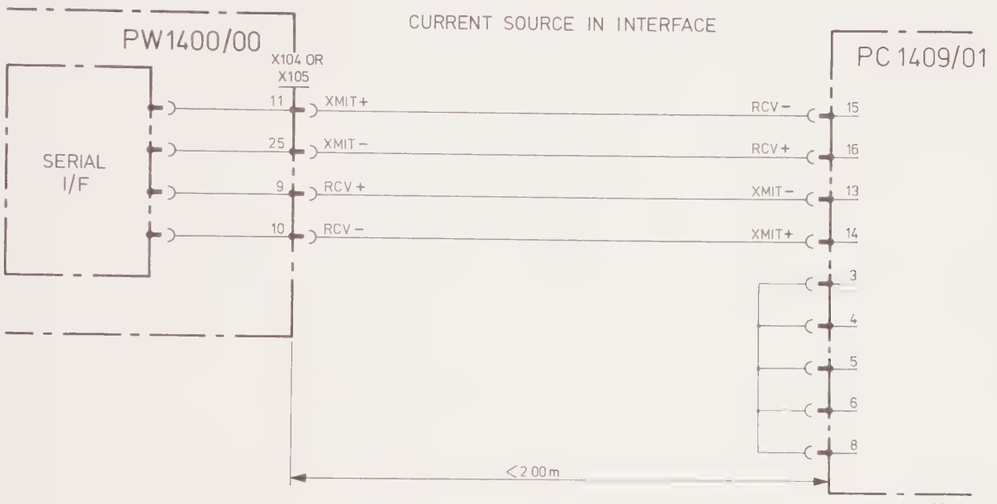
   This version has an interface pcb identical with that of the PC1409/01 and should have its type number modified accordingly. For the connection of this version see the connection data for the PC1409/01.

4. Version with all pins present in the connecting plug. This version has correct timing and can be connected without modifications to the null modem.



DATA TRANSFER ADJUSTMENT

PC 1409/01	SERIAL INTERFACE SEE FIG. 4.3.3.5.1
NOT ADJUSTABLE	S 3 - 1 = C S 3 - 2 = C S 4 - 1 = P S 4 - 2 = P
CONNECTING CABLE WITH JUMPERS MUST BE AS SHOWN HERE	S 5 - 1 = C S 5 - 2 = C (BRIDGE CONTACTS) S 6 - 1 = P S 6 - 2 = P S 9 - 1 = C S10 - 1 = C (BRIDGE CONTACTS) S11 - 1 = C

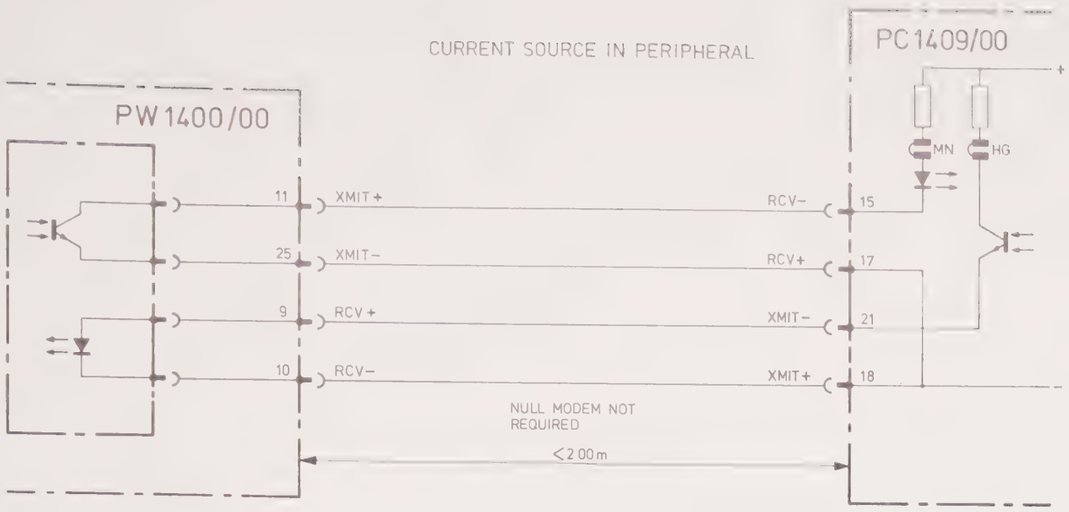


NOT ADJUSTABLE	S 3 - 1 = C S 3 - 2 = C S 4 - 1 = 1 S 4 - 2 = 1
CONNECTING CABLE WITH JUMPERS MUST BE AS SHOWN HERE	S 5 - 1 = C S 5 - 2 = C (BRIDGE CONTACTS) S 6 - 1 = 1 S 6 - 2 = 1 S 9 - 1 = C S 9 - 2 = C S10 - 1 = C (BRIDGE CONTACTS) S11 - 1 = C

Data Format and Baud Rate for Current Loop

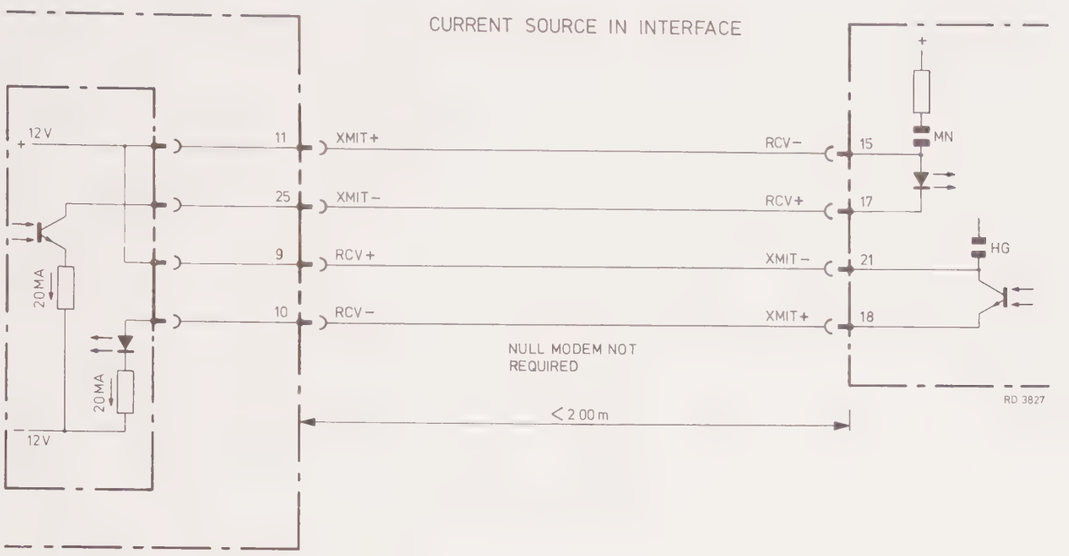
Adjustment	PC1409/01	Serial Interface	
300 Baud	Key 30CPS	S1-1 = 1 S1-2 = 0	
or		S2-1 = 1 S2-2 = 1	
110 Baud	Key 10CPS	S1-1 = 1 S1-2 = 1 S2-1 = 1 S2-2 = 1	
8 bits/character No parity check	Key PARITY CHECK off	S7-2 = 0 S8-1 = X S8-2 = 1	
Echo	Key FDX	S7-1 = 1	
PC1409/01 on line	Key DATA		
Interface address		Interface No. 1 (address 9xxx) J6 = open J7 = open J8 = closed	Interface No. 2 (address Axxx) J6 = open J7 = closed J8 = open
Interface used with 8080ACPU		J2 = closed J3 = open J4 = closed J5 = open	
Interrupt		J9 = open	
Connection PROT. GND to S. GND. Connection PROT. GND to 0 Volts		J1 = closed J10 = closed	

Fig. 4.3.3.6.1.2. Connection of PC1409/01 in current loop mode.



DATA TRANSFER ADJUSTMENT

PC 1409/00 JUMPERS	SERIAL INTERFACE SEE FIG. 4.3.3.5.1
F-D = OPEN	S 3-1 = C
E-D = CLOSED	S 3-2 = C
X-Y = CLOSED	S 4-1 = I
X-Z = OPEN	S 4-2 = I
A-B = CLOSED	S 5-1 = C (BRIDGE CONTACTS)
A-C = OPEN	S 5-2 = C (BRIDGE CONTACTS)
M-N = CLOSED	S 6-1 = I
H-G = CLOSED	S 6-2 = I
I-J = OPEN	S 9-1 = C
K-L = OPEN	S 9-2 = C
P-O = CLOSED	S10-1 = C (BRIDGE CONTACTS)
	S11-1 = C



F-D = OPEN	S 3-1 = C
E-D = CLOSED	S 3-2 = C
X-Y = CLOSED	S 4-1 = I
X-Z = OPEN	S 4-2 = I
A-B = CLOSED	S 5-1 = C (BRIDGE CONTACTS)
A-C = OPEN	S 5-2 = C (BRIDGE CONTACTS)
M-N = OPEN	S 6-1 = I
H-G = OPEN	S 6-2 = I
I-J = OPEN	S 9-1 = C
K-L = OPEN	S 9-2 = C
P-O = CLOSED	S10-1 = C (BRIDGE CONTACTS)
	S11-1 = C

Data Format and Baud Rate for Current Loop

Adjustment	PC1409/01	Serial Interface
300 Baud	Key 30CPS	S1-1 = 1 S1-2 = 0
or		S2-1 = 1 S2-2 = 1
110 Baud	Key 10CPS	S1-1 = 1 S1-2 = 1 S2-1 = 1 S2-2 = 1
8 bits/character No parity check	Key PARITY CHECK off	S7-2 = 0 S8-1 = X S8-2 = 1
Echo	Key FDX	S7-1 = 1
PC1409/00 on line	Key DATA	

Interface address	Interface No. 1 (address 9xxx)	Interface No. 2 (address Axxx)
	J6 = open	J6 = open
	J7 = open	J7 = closed
	J8 = closed	J8 = open

Interface used with 8080ACPU	J2 = closed J3 = open J4 = closed J5 = open
Interrupt	J9 = open
Connection PROT. GND to S. GND.	J1 = closed
Connection PROT. GND to 0 Volts	J10 = closed

Fig. 4.3.3.6.1.3. Connection of PC1409/00 in current loop mode.

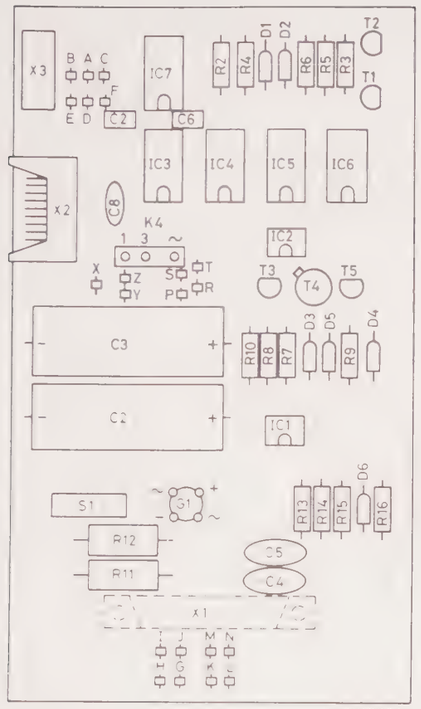


Fig. 4.3.3.6.1.4. PC 1409/00 Interface pcb lay out

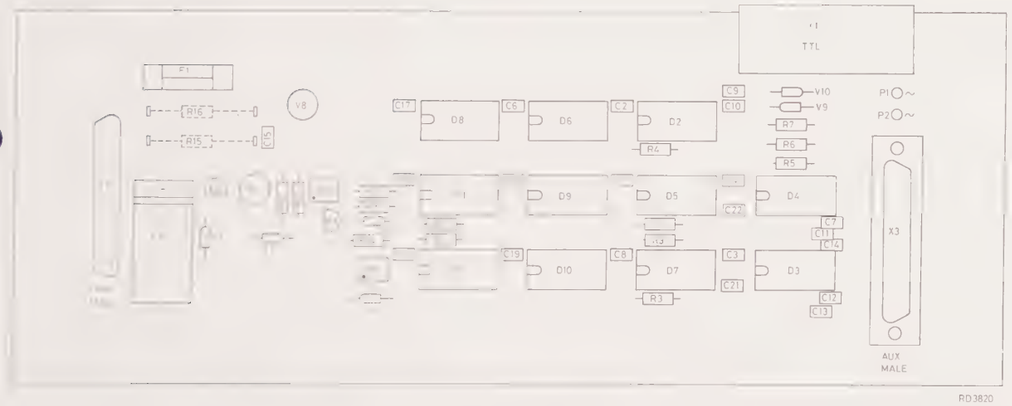
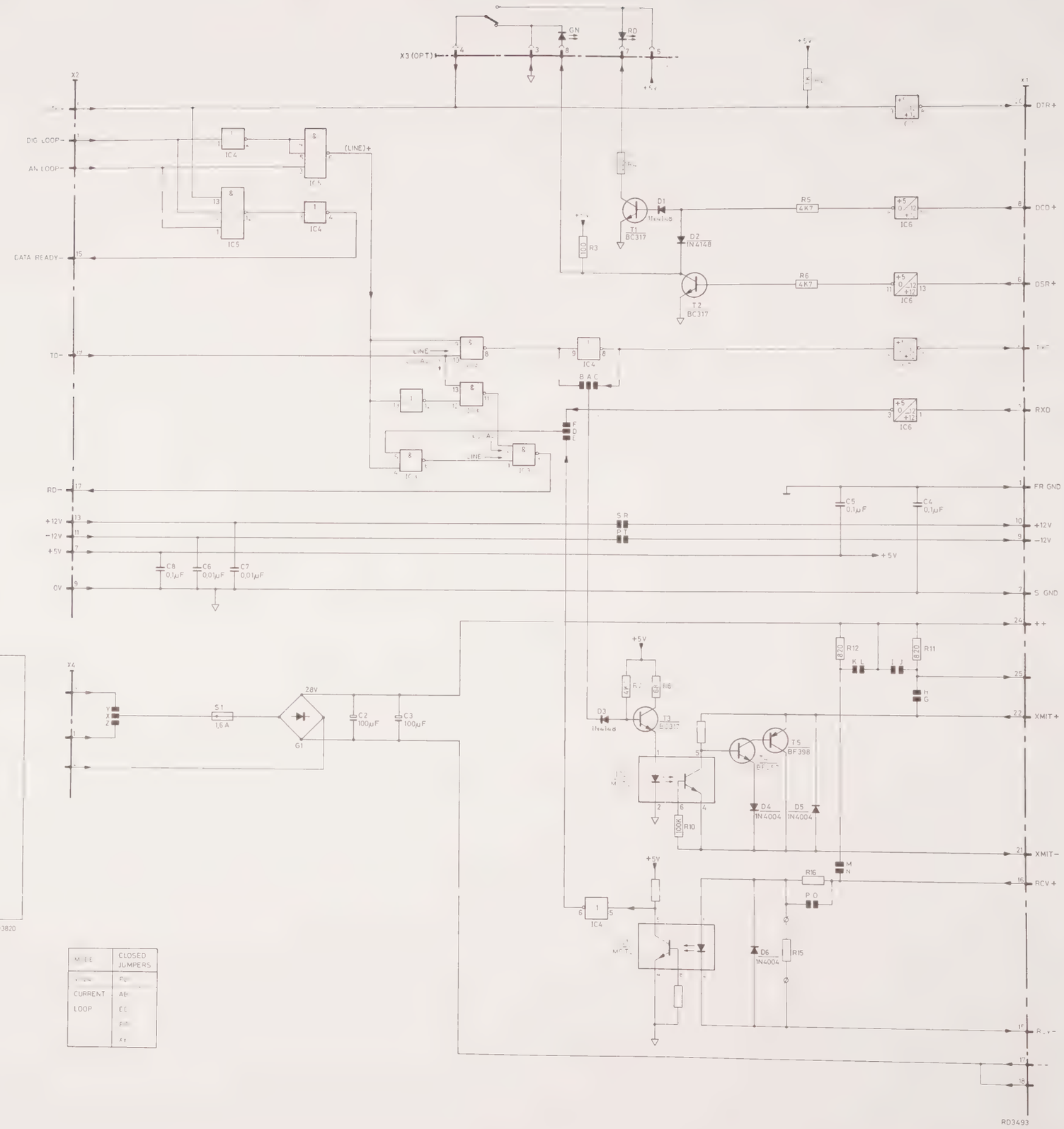


Fig. 4.3.3.6.1.5. PC 1409/01 Interface pcb lay out with jumpers



MODE	CLOSED JUMPERS
CURRENT LOOP	AB CC FF XY

Fig. 4.3.3.6.1.6. PC 1409/00 Interface circuit diagram

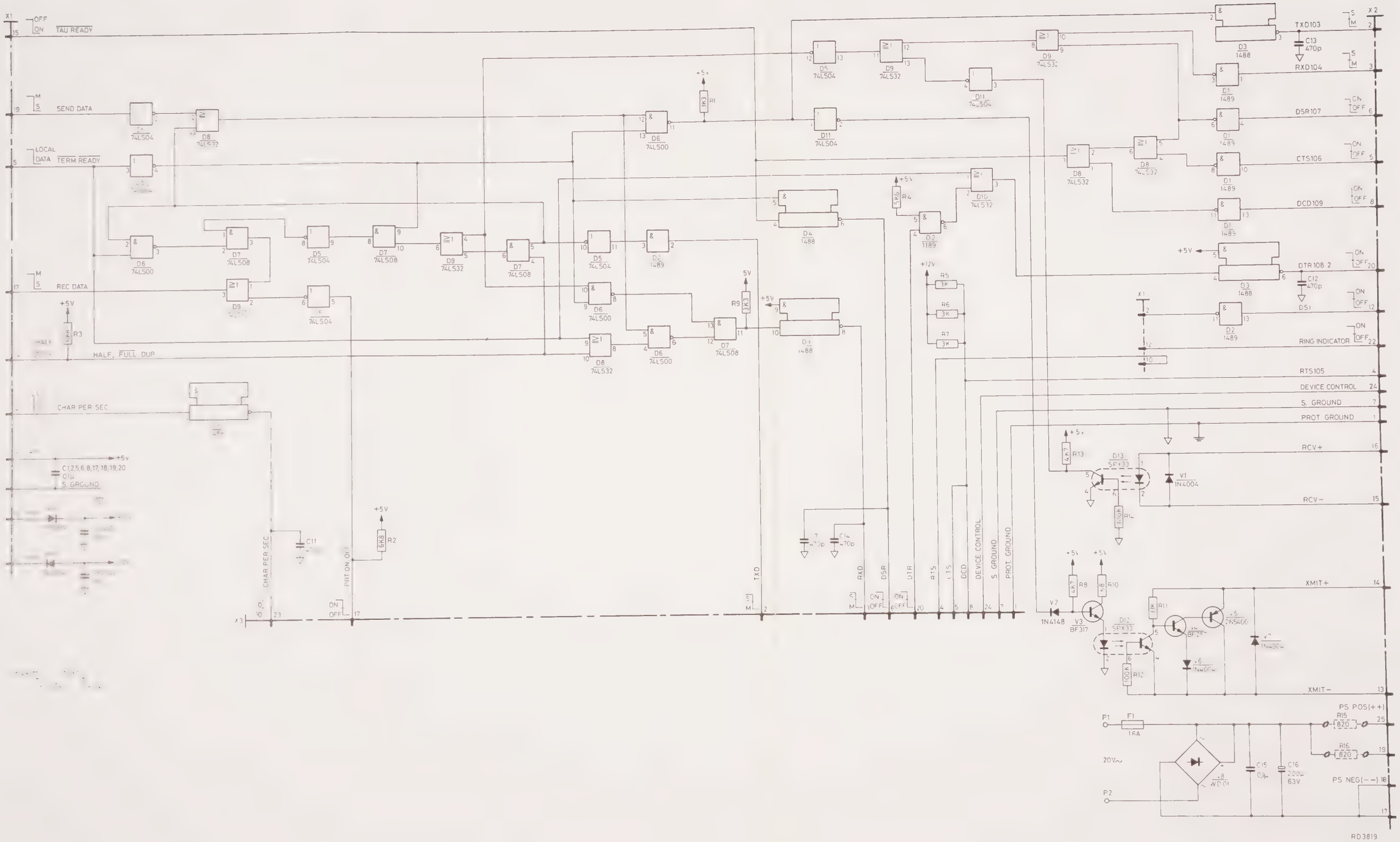


Fig. 4.3.3.6.1.7. PC 1409/01 Interface circuit diagram

4.3.3.6.2. Visual display unit P817

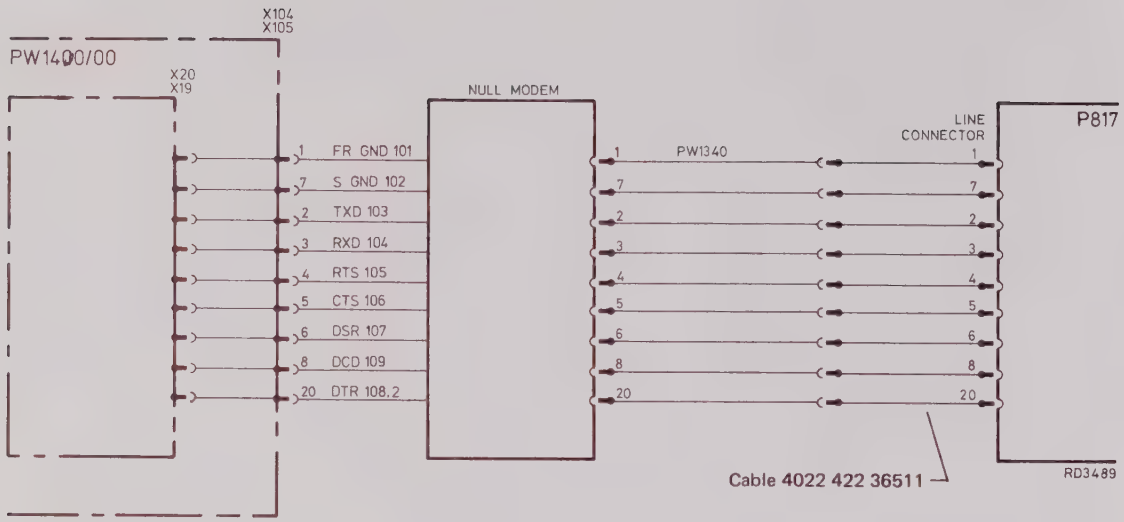
The information given in this section supplements that given in the manuals for the P817:

Publication number 5122 991 28322 P817 supplement
for P800M operators guide (5122 991 27442).

This supplement is supplied with the VDU P817.

The VDU is capable for working at a variety of baud rates but it will usually be an advantage to connect it for 9600 baud. The settings of switches and jumpers given in figure 4.3.3.6.2.1. are based on this assumption.

An optional hard copy V24 interface P817-025 can be fitted to the P817 to enable a printer to be connected to it. This option consists of several integrated circuits which must be inserted in IC holders on the logic pcb. The option enables a hard copy to be obtained of everything which appears on the VDU screen. To enable a hard copy device (e.g. PC1409/00 working in V24 format) to be connected a separate cable, 4022 422 38461, must be used.



Data transfer adjustment

	Serial interface See fig. 4.3.3.5.1.	VDU P817 See fig. 4.3.3.11.
V24	S3-1 = V S3-2 = V S4-1 = X S4-2 = X S5-1 = V S5-2 = V S6-1 = X S6-2 = X S9-1 = V S9-2 = V S10-1 = V S11-1 = V	8 bits/character Parity no 9600 Baud Echoplex

Data format and baud rate

9600 Baud	S1-1 = 0 S1-2 = 0 S2-1 = 0 S2-2 = 1
No parity check (8 bits/char.)	S8-1 = X S8-2 = 1 S7-2 = 0
Echo	S7-1 = 1

Serial interface
Jumper settings

Connection between protective ground and signal ground J1 = closed

Connection between protective ground and logic 0 V J10 = closed

Serial interface no. 1 (address 9xxx)	Serial interface no. 2 (address Axxx)
J6 = open	J6 = open
J7 = open	J7 = closed
J8 = closed	J8 = open

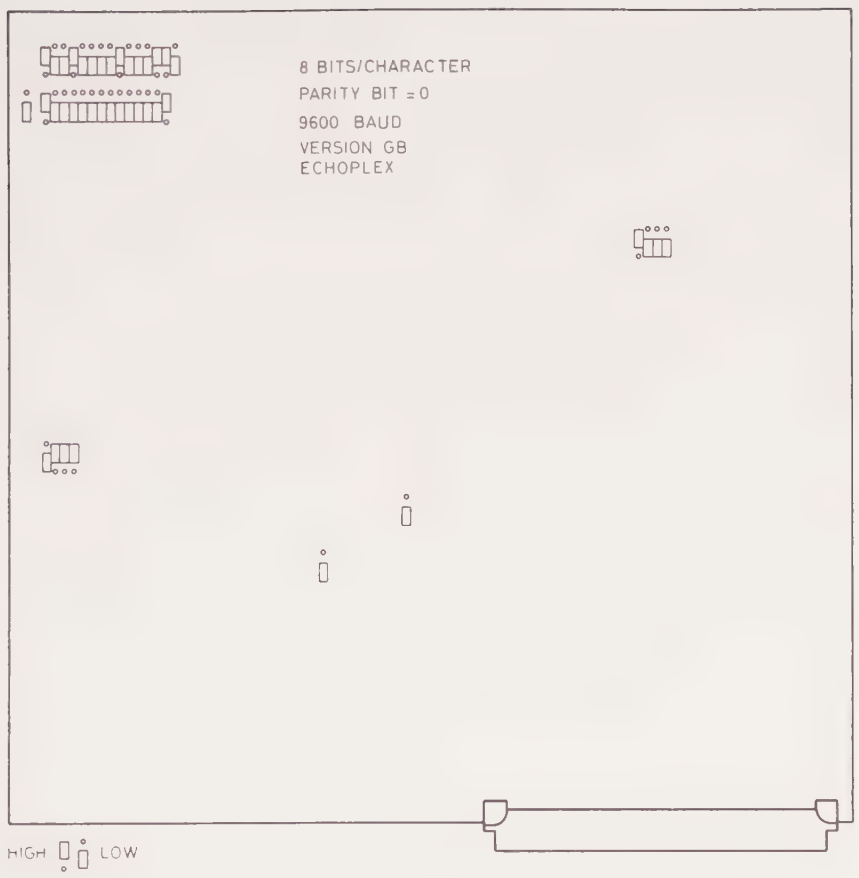
Polarity of WR and RD (DBIN) signals = active high

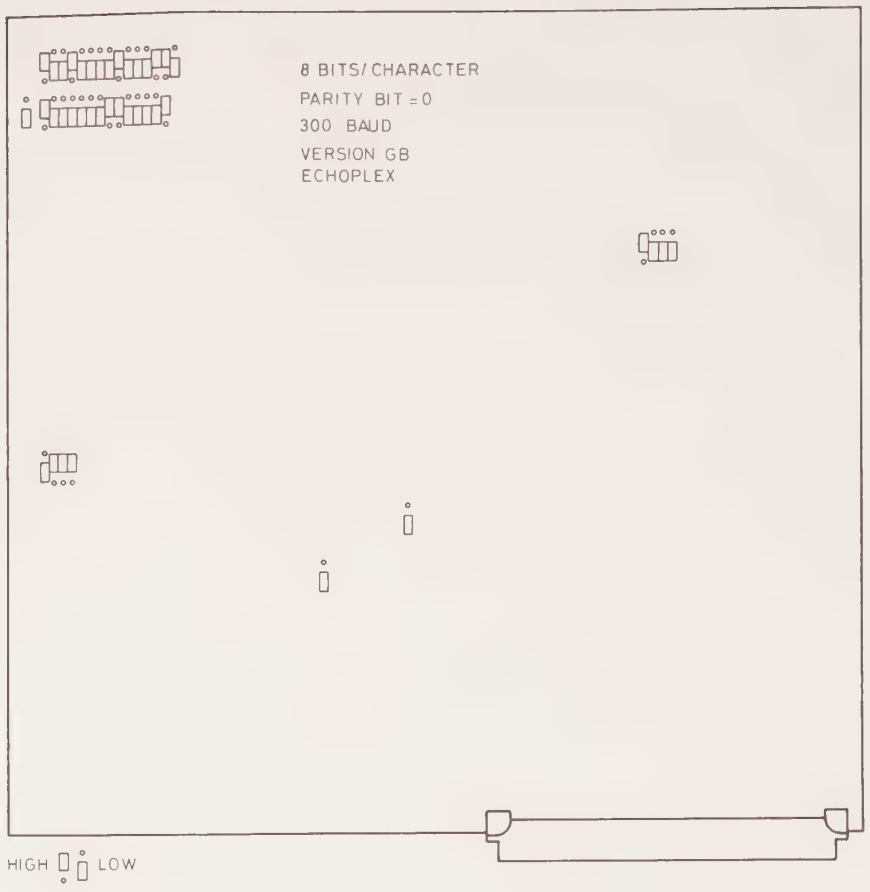
J2 = closed
J3 = open
J4 = closed
J5 = open

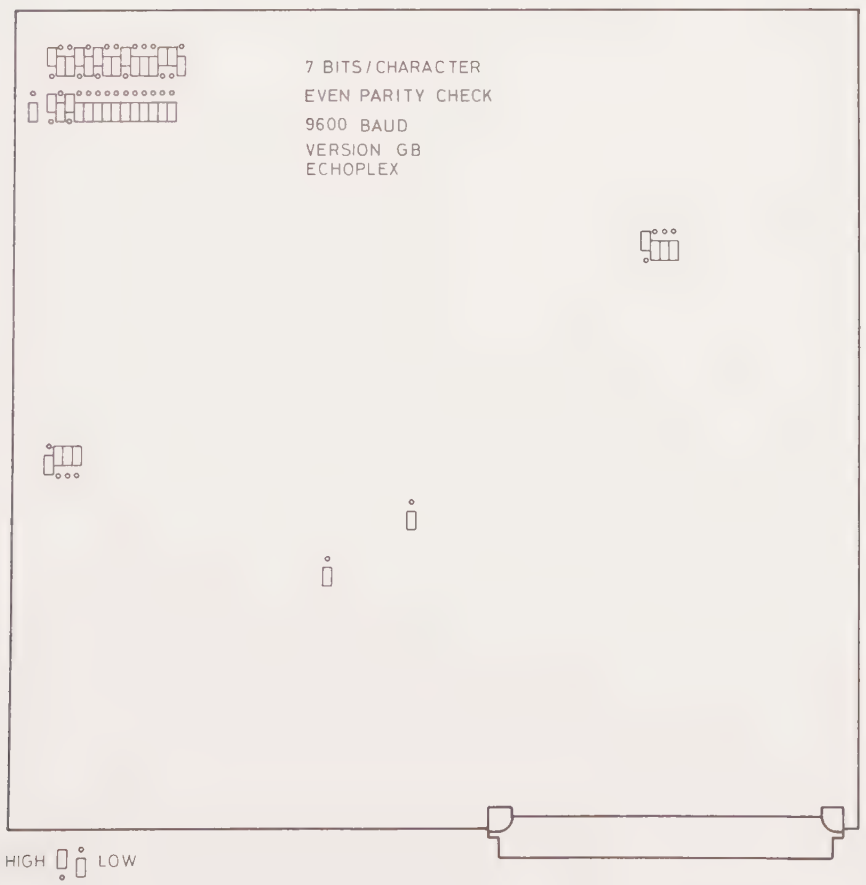
Interrupt

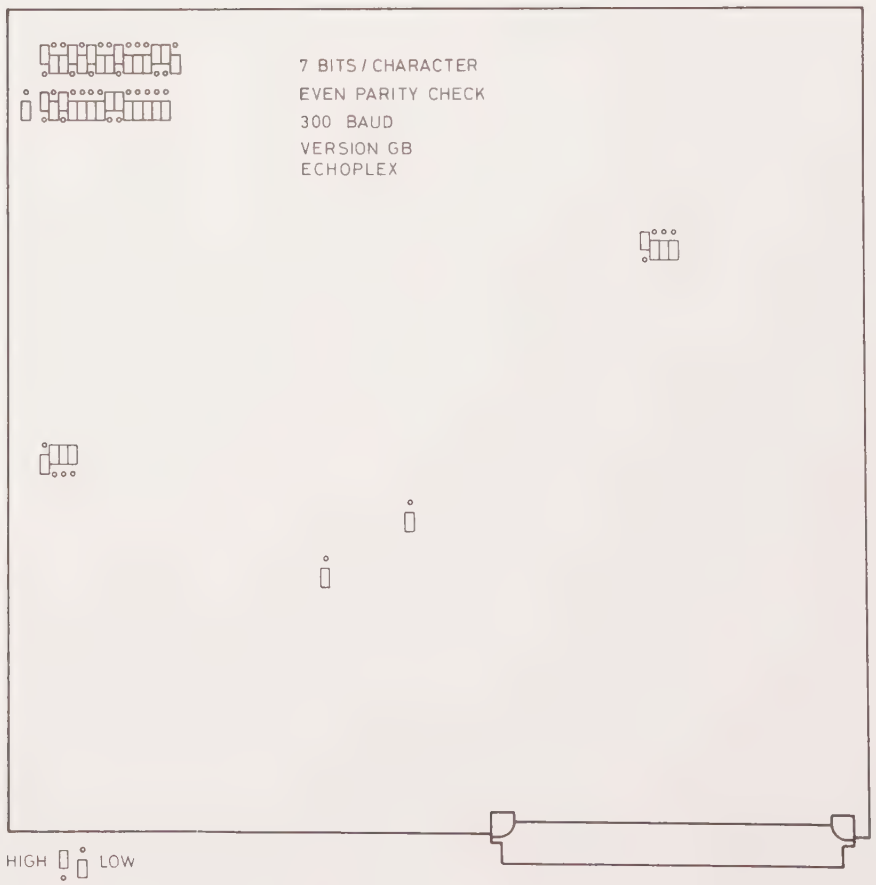
J9 = open

Fig. 4.3.3.6.2.1. Connection of VDU P817.









RD3496

Fig. 4.3.3.6.2.2. P817 Interface pcb

P817-025 Optional hard-copy interface

The P817-025 consists, a baud-rate generator IC OSC 04, a USART, and three RAMS. These must be inserted in the IC holders on the logic pcb as follows (see also fig. 4.3.3.6.2.3):

IC	Position
Baud-rate generator OSC 04	B1 D4
USART	F6 B9
RAM	C9 G4
RAM	D8 G4

The following hardware straps must be set:

Name	Position	Function
SCRL	A5 H8	Roll-up
SW	B1 H8	Switched
SYN	B0 H4	Delay time for printer
STRP3	A9 H8	Parity bit to printer
STRP2	A5 H4	Even parity to printer
SELA6	A6 H4	Only upper case letters on printer
S0	A8 D5	= 1
S1	A5 D5	Transmission speed = 0
S2	A6 D5	to printer = 1
S3	A7 D5	= 1
		} for 300 baud
PRN	H0 F9	Auxiliary interface installed

The P817 contains all the necessary internal wiring. The hard-copy device (e.g. PC1409), which must be connected for V24 format, must be connected to connector CD2 at the back of the display unit via a cable 4022 422 38461.

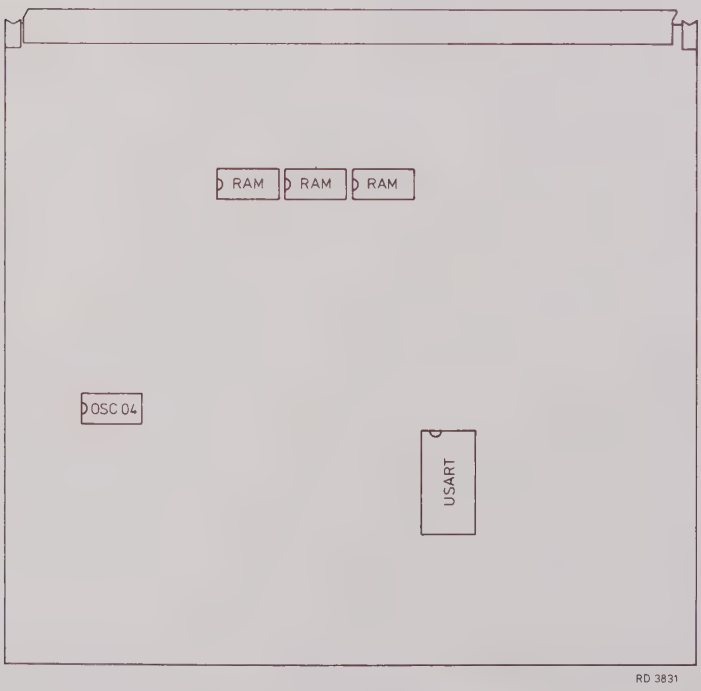


Fig. 4.3.3.6.2.3. Position of IC's for option P817-025

4.3.3.6.3. PW1790/11 P851 Minicomputer system

The information given in this section concerns the connection of a PW1790/11 minicomputer system to interface No. 1 in the PW1400/00.

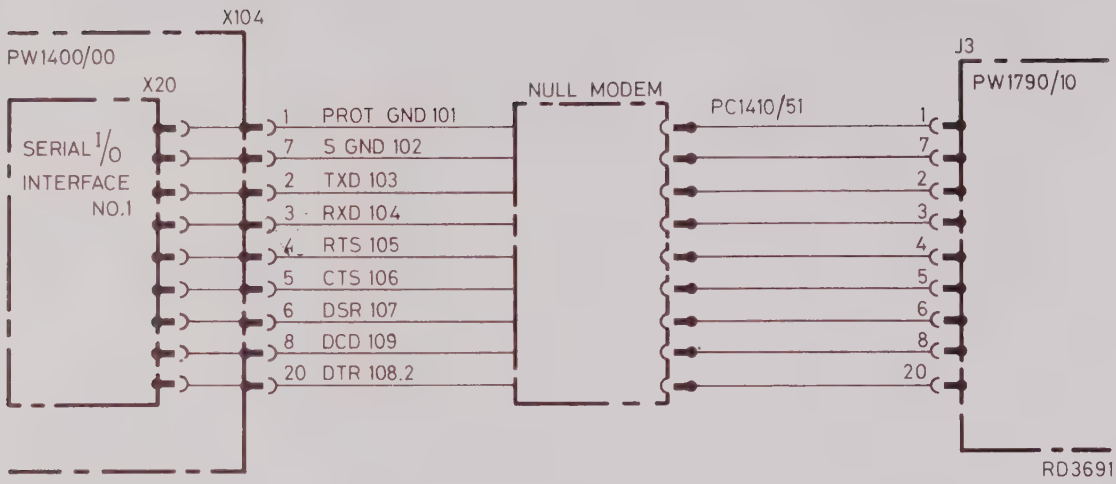
The setting for jumpers on the SALCUZ interface pcb's will be found in the service manual for the PW1790/11.

Survey of P851 interrupt levels and device addresses in the PW1790/11.

Int.level	Address	Slot	Device
/0	—	1	Power failure
/1	—	1	LKM
/2	—	1	Real-time clock
/5	/3, /13, (/23, /33)	4-5	Floppy disc drive
/6	/10	6	SCUZ for operator's terminal
/7	—	1	CPU Interrupt pushbutton, or BREAK key on terminal
/A	/3A	7	SALCUZ input from PW1400/00
/B	/3B	7	SALCUZ output to PW1400/00
/D	/07	8	Wired and reserved for hardcopy device via SCUZ (LP)
/E	/3C	9	Wired and reserved for auxiliary SCUZ (RT)
—	—	2	I/O processor
—	—	3	32k word memory

In general, for each terminal to be connected a P845-140 SCUZ interface pcb must be inserted in the appropriate slot, and a PC1410/11 connecting cable will be required.

The PW1790/11 includes a full control panel for the P851 minicomputer.
Various test programs on floppy discs are included in the service kit 9430 900 00951.



Data transfer adjustment

	Serial interface (see fig. 4.3.3.5.1.)	PW1790/10 minicomputer
V24	S3-1 = V	See service manual
	S3-2 = V	
	S4-1 = X	PW1790/10
	S4-2 = X	
	S5-1 = V	
	S5-2 = V	
	S6-1 = X	
	S6-2 = X	
	S9-1 = V	
	S9-2 = V	
	S10-1 = V	
	S11-1 = V	
9600 Baud	S1-1 = 0	
	S1-2 = 0	
	S2-1 = 0	
	S2-2 = 1	
No parity check	S7-2 = 0	
(8 bits/char.)	S8-1 = X	
	S8-2 = 1	
No Echo	S7-1 = 0	

Serial interface jumper settings

Connection between protective ground and signal ground	J1 = closed
Connection between protective ground and logic 0 V	J10 = closed
Serial interface No. 1 (address 9 xxx)	J6 = open
	J7 = open
	J8 = closed
Polarity of WR and RD (DBIN) signals: active high	J2 = closed
	J3 = open
	J4 = closed
	J5 = open
Interrupt	J9 = open

Fig. 4.3.3.6.3. Connection of minicomputer system PW1790/10.

4.3.3.6.4. Minicomputer system PDP11

The information given in this section applies to the setting of jumpers and switches on the serial I/O interface No. 1 for the connection of the DEC minicomputer system PDP11.

The setting of jumpers on the PDP11 interface pcb will be found in the documentation delivered with the minicomputer.

The connecting cable required to connect the minicomputer system to the null modem is supplied as part of the PDP11 interface pcb.

The basic hardware to control the PW1400/00 spectrometer consists of a 32 kwords PDP11/04 in a 5.25" chassis, mounted together with a dual floppy disc system in a 19" cabinet. A terminal must be connected to this system via a terminal control unit. As an option a line printer may also be connected to the system. The RT-11 software (version 3B) and the FORTRAN compiler and library must be ordered with this system.

The connection with the PW1400 spectrometer goes via a DL11-E modem controlling EIA/CCITT serial line interface. This interface should be fitted with Crystal number 4 (giving 9600 baud). A cable of 7.6 m is included in this type number. The cable has to be connected to the PW1400/00 spectrometer via a null modem.

As an example a DEC system for a 50 Hz 220 V spectrometer could consist of:

1 PDP11/04-LD, CPU and 32 kwords MOS memory.
1 DL11-WB, EIA terminal interface, real time clock and cable.
1 RX11-BD, dual floppy disc and control unit.
1 H312-A, null modem for the terminal connection.
1 LA36-HJ, printing terminal.
1 H967-CB, 19" cabinet.
1 QJ926-CY, RT11 + FORTRAN software.
1 DL11-E, modem controlling EIA/CCITT serial line interface and cable.

If the operators terminal is a VDU and a hard-copy output is required, a lineprinter should be connected to this system (e.g. LA11-PD).

If a graphics terminal is required, the operator terminal should be replaced by the DEC VT55 VDU or by the HP graphics terminal.

The HP graphics terminal, type number HP 2649C, should be connected with option 015 for 220 V and cable 13232M. This is the OEM type number of the HP 2648A graphics terminal. If a hard-copy of the graphics output is required, the HP 2631G/015 graphics printer should be connected with the following extra options in the HP 2649C terminal: HP 13296A/0048 (HP IB interface) and 13261A/003 (ROM for device support firmware). A baud rate of 2400 should be selected on the terminal and on the interface in the computer.

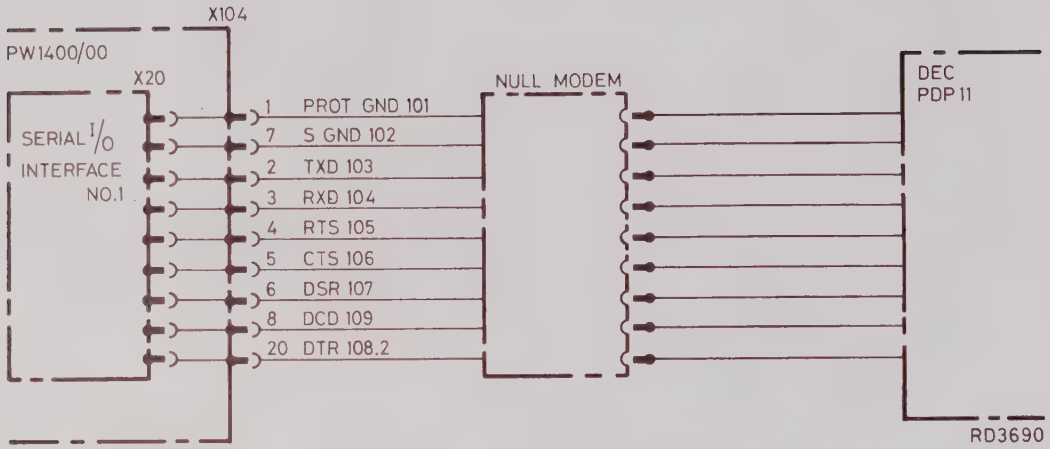
The system configuration given here may be different in practice because type numbers are liable to change.

Interfaces and addresses in PDP11/04

Interface for	Interface Type No.	Page address	Vector (int) level
PW1400/00	DL11-E	175610	300
Operators Terminal	DL11-WB	177560	060
Remote Terminal (Printer) — V24	DL11-WB	175620	310
— current loop	DL11-WA		

Interfaces and addresses in PDT11-150

Interface for	Interface Type No.	Page address	Vector (int) level
PW1400/00	DL11-E	176610	330



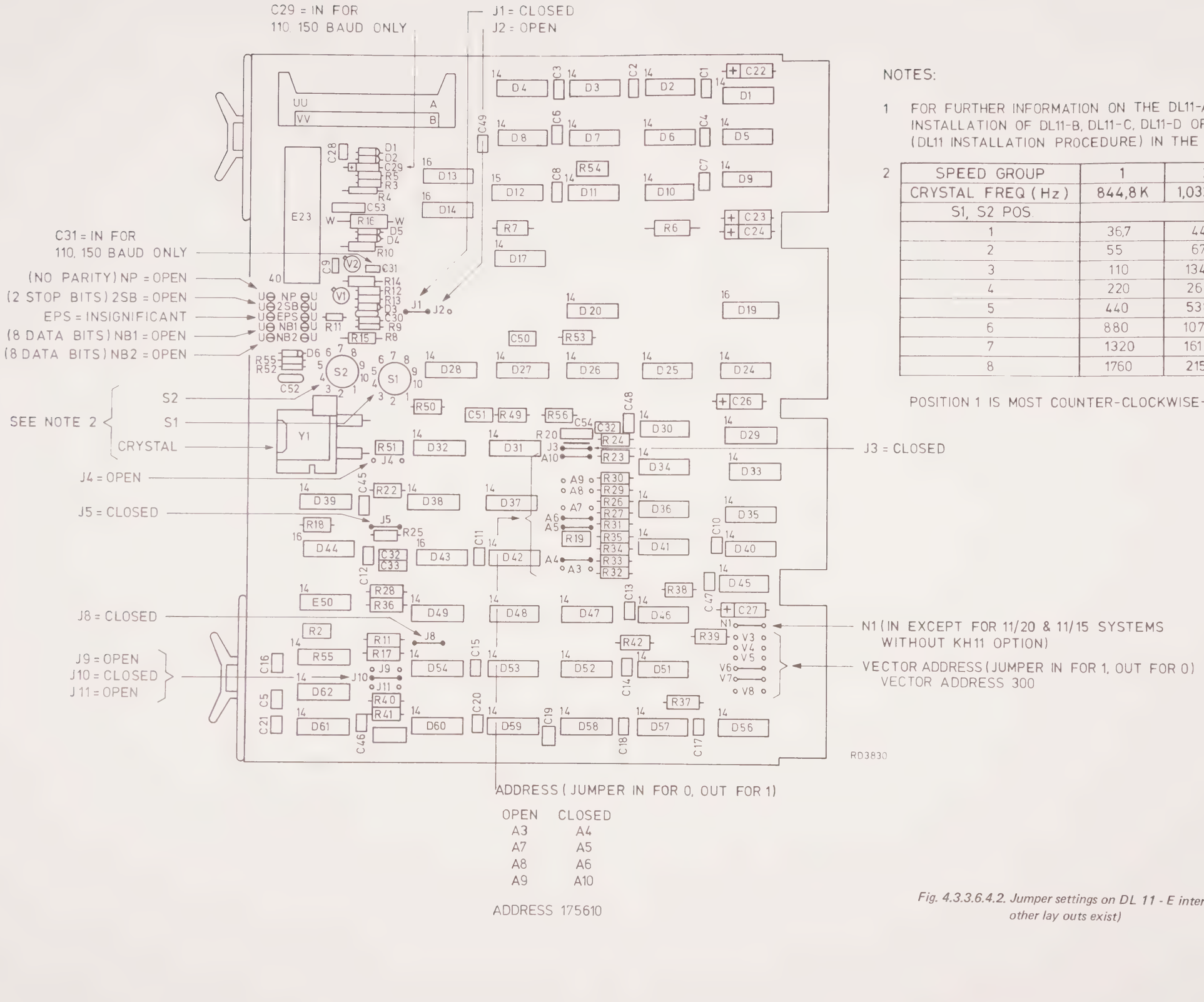
Data transfer adjustment

	Serial interface (see fig. 4.3.3.5.1.)	PDP11 Minicomputer
V24	S3-1 = V S3-2 = V S4-1 = X S4-2 = X S5-1 = V S5-2 = V S6-1 = X S6-2 = X S9-1 = V S9-2 = V S10-1 = V S11-1 = V	See fig. 4.3.3.6.4.2. and refer to documentation for DL11-E pcb delivered with PDP11.
9600 Baud	S1-1 = 0 S1-2 = 0 S2-1 = 0 S2-2 = 1	
No parity check	S8-1 = X S7-2 = 0	
8 bits/char.	S8-2 = 1	
No Echo	S7-1 = 0	

Serial interface jumper settings

Connection between protective ground and signal ground	J1 = closed
Connection between protective ground and logic 0 V	J10 = closed
Serial interface No. 1 (address)	J6 = open J7 = open J8 = closed
Polarity of WR and RD (DBIN) signals: active high	J2 = closed J3 = open J4 = closed J5 = open
Interrupt	J9 = open

Fig. 4.3.3.6.4.1. Connection of DEC minicomputer system PDP11



NOTES:

1 FOR FURTHER INFORMATION ON THE DL11-A CONFIGURATION OR THE INSTALLATION OF DL11-B, DL11-C, DL11-D OR DL11-E REFER TO A-SP-DL11-0-2 (DL11 INSTALLATION PROCEDURE) IN THE DL11.

2

SPEED GROUP	1	2	3	4
CRYSTAL FREQ (Hz)	844,8 K	1,03296M	1,152M	4,608M
S1, S2 POS.	BAUD RATE			
1	36,7	44,8	50	200
2	55	67,3	75	300
3	110	134,5	150	600
4	220	269	300	1200
5	440	538	600	2400
6	880	1076	1200	4800
7	1320	1614	1800	7200
8	1760	2152	2400	9600

POSITION 1 IS MOST COUNTER-CLOCKWISE-POSITION.

Fig. 4.3.3.6.4.2. Jumper settings on DL 11 - E interface pcb (typical pcb lay out, other lay outs exist)

4.3.3.6.5. Calculator HP 9815A

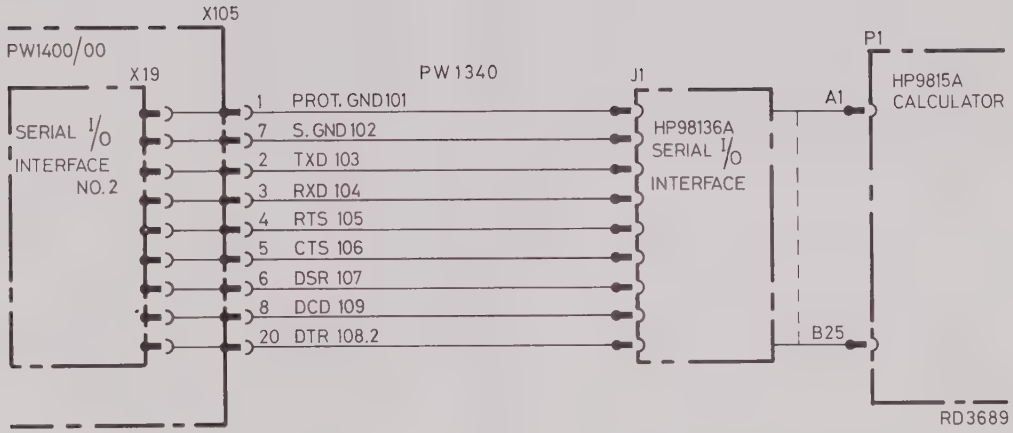
The information given in this section applies to the setting of jumpers and switches on the serial I/O interface No. 2 for the connection of the Hewlett-Packard calculator HP 9815A via cable PW1340.
Also given are settings for jumpers and switches in the Hewlett-Packard I/O interface HP 98136A.

The terminal configuration must consist of:

Calculator	HP 9815A or S
Serial I/O interface	HP 98136A
or	
20 mA current loop interface	Option 001

Before connecting the interface to the calculator, ensure that the calculator is switched off.
Insert the interface in one of the slots in the calculator.

Note that no null modem is required for this configuration.



Data transfer adjustment

	Serial interface (see fig. 4.3.3.5.1.)	HP 98136A Serial I/O interface
V24	S3-1 = V	Format switch
	S3-2 = V	
	S4-1 = X	1 open
	S4-2 = X	2 open 8 bits/char.
	S5-1 = V	3 open
	S5-2 = V	4 open no parity
	S6-1 = X	5 open
	S6-2 = X	6 not used
	S9-1 = V	7 open
	S9-2 = V	8 open
	S10-1 = V	9 closed
	S10-2 = V	10 open
2400 Baud	S1-1 = 1	Baud rate switch = 8
	S1-2 = 1	
	S2-1 = 1	
	S2-2 = 0	
No parity check	S7-2 = 0	
	S8-1 = X	
8 bits/char.	S8-2 = 1	
Echo	S7-1 = 1	

Serial interface jumper settings

Connection between protective ground and signal ground	J1 = closed
Connection between protective ground and logic 0 V	J10 = closed
Serial interface No. 2 (address)	J6 = open J7 = closed J8 = open
Polarity of WR and RD (DBIN) signals: active high	J2 = closed J3 = open J4 = closed J5 = open
Interrupt	J9 = open

Fig. 4.3.3.6.5. Connection of calculator HP 9815A and interface HP 98136A.

4.3.3.6.6. Connection of a modem

The PW1400/00 can be operated remotely via a telephone line and modems. This permits the operator's terminal (e.g. P817 VDU or PC1409 teleprinter) to be situated at some considerable distance from the spectrometer.

A modem which must be connected to a public telephone network must be of a type which is applied by the telephone authorities. In many countries a modem may only be connected by the telephone authority's own engineers.

Most modems designed to operate at 100-300 baud accept standard V24 (RS232-C) signals, and communicate over a line by means of frequency modulated signals. In most of these two channels, one for sending and the other for receiving, are used. The channels may have the following characteristics:

channel 1 — Nominal frequency: 1080 Hz
F2 = 980 Hz (logic 1)
FA = 1180 Hz (logic 0)

channel 2 — Nominal frequency: 1750 Hz
F2 = 1650 Hz (logic 1)
FA = 1180 Hz (logic 0)

It is essential that the modems are adjusted so that their transmission frequencies are the same, and that they be capable of working in full-duplex mode.
It is also essential the serial interface and the remote terminal be adjusted to have the same operating characteristics, e.g.

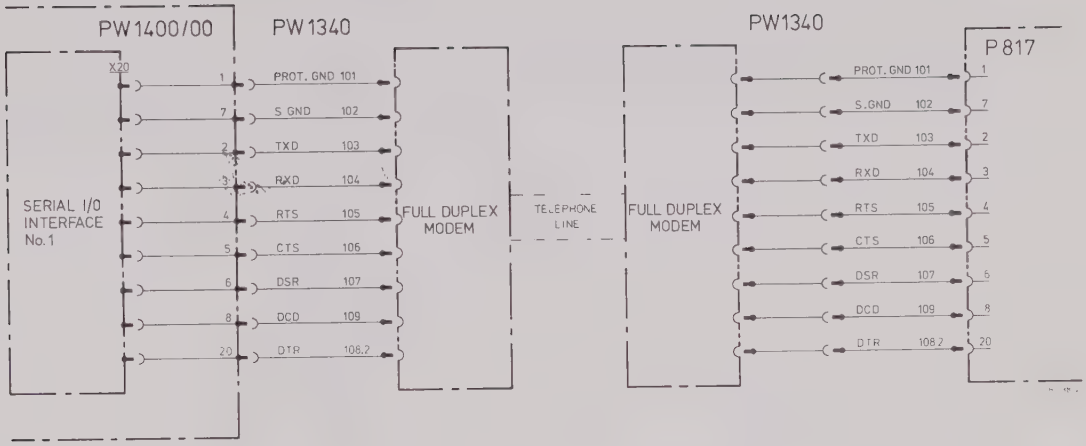
Baud rate
Number of bits/character
Echo/no echo
Number of stop bits
Parity/no parity
Even or odd parity

Modems intended to be connected private lines or internal (non-public) telephone networks can be chosen to suit the individual requirements.

A typical set-up involving the connection of a P817 VDU to a PW1400/00 via a telephone line and modems is shown in fig. 4.3.3.6.6.1.

NOTE

The baud rate of the remote terminal and the serial interface must not exceed the capability of the modems.



Data transfer adjustment

	Serial interface see fig. 4.3.3.5.1.	VDU P817 see fig. 4.3.3.11.
V24	S3-1 = V S3-2 = V S4-1 = X S4-2 = X S5-1 = V S5-2 = V S6-1 = X S6-2 = X S9-1 = V S9-2 = V S10-1 = V S10-2 = V	8 bits/character Parity: No 300 Baud Echoplex

Data format and baud rate

300 baud	S1-1 = 1 S1-2 = 0 S2-1 = 1 S2-2 = 1
No parity check	S8-1 = X
8 bits/char.	S8-2 = 1 S7-2 = 0
Echo	S7-1 = 1

Serial interface jumper settings

Connection between protective ground and signal ground	J1 = closed
Connection between protective ground and logic 0 V	J10 = closed
Serial interface No. 1 (address 9xxx)	J6 = open J7 = open J8 = closed
Polarity of WR and RD (DBIN) signals active high	J2 = closed J3 = open J4 = closed J5 = open
Interrupt	J9 = open

4.3.4. Bus interface

4.3.4.1. Introduction

The bus interface p.c.b. is the link between the micro computer bus and the equipment bus (fig. 4.3.4.1.).
It contains an address decoder to select the p.c.b. and level converters for the data, address and control bus, interrupt request circuitry with reset possibility, and priority encoder. It also contains a ready circuit which matches the slow equipment bus with the fast microcomputer bus.
The power level sense circuitry senses the voltages used in the equipment and generates a reset signal if a voltage fails. The standby supply is used to save the contents of the RAM memory if the equipment is switched off.

4.3.4.2. The interrupt circuit

The microprocessor in the system can be interrupted by an external interrupt. These interrupts are:

Device	Signal name
Serial interface 1	INTR 7+
Serial interface 2	INTR 6+
Spectrometer control 2	INTR 5–
Spectrometer control 1	INTR 4–
Counter time	INTR 3–
Position control	INTR 2–

When the system is switched on the signal PON– is generated on the CPU board and this signal resets via D26-6 [fig. 4.3.4.2. E/2] the status latch D10 [A/13] so output D10–12 becomes "1" and enables the interrupt request latch D21 [C/11]. The latches in D21 can be set by the signals INTR2–5– via the gates D19 and D28 [C/9].

As soon as one of the outputs of D21 or one of the signals INTR 6+ or INTR7+ becomes "1" the output 14 of the priority encoder D22 [C/13] becomes "1" and signal INT+ becomes "1" via D26–6 [D/14].
This signal interrupts the microprocessor in the following way as shown in fig. 4.3.4.3.
The signal INT+ may be asynchronous and may be generated at any time during an instruction cycle, and provided that the internal interrupt enable INTE is "1" the interrupt will be accepted.
The signal INT+ is clocked into the microprocessor by clock pulse Ø2 during the last stage of the instruction cycle. This ensures that any instruction in progress is completed before the interrupt is processed.

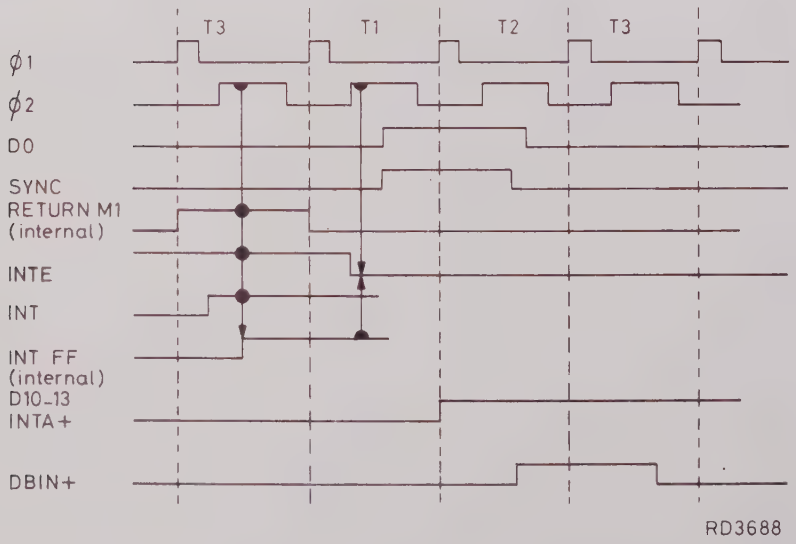


Fig. 4.3.4.3. Microprocessor clock and interrupt signals.

When an interrupt is clocked into the microprocessor the internal interrupt flip-flop is set. This ensures that when signal sync is preset the following word is set on the data bus.

D7 D0
0 0 1 0 0 0 1 1

The D0 = "1" is clocked into the status latch D10 [A/13] and makes signal INTA+ "1" via D26–2 [A/14]. The signal INTA+ disconnects the memory from the data bus. The signal INTA– disables the interrupt request latch D21 [C/11] in such a way that the outputs become isolated from the internal flip-flops (outputs floating). New incoming interrupts are still set into the flip-flops but they are not connected to the outputs. The priority encoder D22 [C/13] converts the interrupt signals to a binary code as shown in table 1.

Signal INTRxx+ INTRxx–	Input D22xx	Output D22xx	Data Dxx+
7 6 5 4 3 2	4 3 2 1 13 12	6 7 9	7 6 5 4 3 2 1 0
1	1	1 1 1	1 1 1 1 1 1 1 1
1	0 1	1 1 0	1 1 1 1 0 1 1 1
0	0 0 1	1 0 1	1 1 1 0 1 1 1 1
0	0 0 0 1	1 0 0	1 1 1 0 0 1 1 1
0	0 0 0 0 1	0 1 1	1 1 0 1 1 1 1 1
0	0 0 0 0 0 1	0 1 0	1 1 0 1 0 1 1 1

Table 1. Interrupt signals in binary form.

When signal SYNC becomes "0" during timing T2, signal DBIN becomes "1" and makes, via D26–12 [D/2] and D11–2 [B/12], the input 12 of D4 [B/14] "0".
The status latch D10 [A/13] was already set so the two inputs of D4–11 [B/4] are "0", which results in the enable inputs of the interrupt vector generator D16 and D25 [C/14]being "0".
On the data bus the output signals of D16 and D25 are now available. The data bits Dxx can have the values as shown in the foregoing table. The bits D7,6 2,1 and 0 represent the instruction restart.

D7 D0
1 1 n n n 1 1 1

This means that the microprocessor loads the program counter with:

8x (n n n)

Which results in the start address of the interrupt subroutines on the following memory addresses:

INTR	Address	Program counter
7	56	0 0 1 1 1 0 0 0
6	48	0 0 1 1 0 0 0 0
5	40	0 0 1 0 1 0 0 0
4	32	0 0 1 0 0 0 0 0
3	24	0 0 0 1 1 0 0 0
2	16	0 0 0 1 0 0 0 0

4.3.4.3. Bus Timing

The businterface p.c.b. contains a circuit which makes it possible to synchronize a slow device on the equipment bus with the microcomputer bus. The synchronization is done with the aid of the counter D3 [B/5], which gets its clock pulse from ϕ in. The counter D3 is normally in its reset position but is enabled as soon as the signal on the reset input becomes low. This signal can become low when there is a low level on an input of D5–10 [A/4]. This can happen when signal SLSIF– = "0" and signal SLBUS– = "1" (this is "1" because SLSIF is selected). The ϕ in /5 signal of the counter D3 [A/5] is "0" when the number of lock pulses ϕ is < 5, so output 3 of D4 [B/4] is "0" which causes V21 [C/5] to conduct via D5–4 [C/4] making signal READY+ "0", and setting the microprocessor in the idle state. When the counter D3 [A/5] has counted five ϕin pulses the output 1 becomes "1" and signal READY+ becomes true, so that the microprocessor can continue.

When the equipment bus must be selected the signal SLBUS– is "0". This signal enables the or gate D4–10 [A/3] for the READY+ signal coming from the p.c.b.'s connected to the equipment bus.
As soon as the signal SLBUS– becomes "0" the counter D3 [B/5] starts counting, because signal READY+= "1", and via D4–10 and D5–10 [B/4] the reset input of the counter becomes "0". At the same moment the signal SLBUS+ enables the gates D6, D14 and D17 [D/3], with the result that the signals WR+, DBIN+ and A0–7 of the microprocessor are transferred to the equipment bus via the bus converter ic's D12, D13 and D23 [D/4].
By means of the signals ADRM0...3 one of the p.c.b.'s connected to the equipment bus is selected, and as soon as this happens the signal READY+ becomes "0" and makes output 10 of D4 "1" which results in the reset input 15 of the counter D3 being "1" because signal SLSIF– = "1".
The counter is held in the reset condition as long as the signal READY+ stays at "0" so that the microprocessor is in the idle state and the signals at the outputs of the address and data lines are stable.
Depending on the level of DBIN+ or WR+ a read or write cycle is executed. If DBIN+ = "1" the signal IORED– becomes "0" via D26 and D17 [D/3] and enables D18 and D27 [K/3], so data on the IOBU0...7 lines can be transferred to the microprocessor. At the moment that READY+ of the selected p.c.b. becomes "1" the counter D3 counts five ϕin pulses and when output 1 becomes "1", signal READY+ goes high, and the microprocessor continues with cycle T3 and the data is read in. The signal IORED– = "0" disconnects the D0–7 lines from IOBU0...7 via the gates D17 [D/4] and D23 [D/4] because D20 and D29 [H/4] are disabled.
When a write cycle is executed the signal IOWRT– is "0" and IORED– is "1".

This means that input 11 of D23 [D/4] becomes "0" via D17 [D/4] and D20 and D29 are enabled, so data transfer from the microprocessor to the selected p.c.b. is possible.

4.3.4.4. General reset

On the bus interface p.c.b. all the power supply voltages are sensed by an opamp which compares the voltages with the +5 V supply. When the voltage is correct a LED on the front of the p.c.b. is lit.
When all voltages have reached their nominal values the inputs of gate D9 [F/12] are "1", which results in input 11 of D9 [F/13] being "1" and the enable input 15 of D27 [F/14] being high if input 9 of D9 [F/14] is "1".
This input is "1" when the switch S2 on the front panel of the p.c.b. is in its rest position. Because input 15 of D27 [F/14] is high the gate is not enabled, so the output signal RESIN– is floating. As soon as the switch S2 is operated or one of the supply voltages disappears the enable input of D27 [F/14] becomes "0" and signal RESIN– goes low. This signal goes to the microprocessor p.c.b. and resets the "power on reset timer" on this p.c.b. This timer resets the microprocessor which means that the program counter inside the processor is reset to zero so the program execution starts at memory location zero.

4.3.4.5. The signals SLSIF, SLBUS and SLINT

Signals SLSIF, SLBUS and SLINT are generated on the bus interface p.c.b. The signals are used for the following purposes:

SLSIF when the serial interface must be used

SLBUS when the equipment bus must be used

SLINT when the interrupt request latch must be reset

The generation of the signals is done via the signals A13–A15 of the microprocessor.
As shown in the following table:

A15	A14	D7–9	SLSIF–	A13	SLBUS–	SLINT–
0	0	1	1	X	X	X
0	1	1	1	X	X	X
1	0	1	0	X	X	X
1	1	0	1	0	0	1
1	1	0	1	1	1	0

The signal SLINT– enables the gates which are connected to the reset inputs of the interrupt request latch D21 [B/10] so that via the data lines this latch can then be reset.

4.3.4.6. Memory supply+ 5Vp

On the bus p.c.b. is an electronic circuit which generates a supply voltage +5Vp to energise the memory on the memory p.c.b.
This voltage can be generated in three different ways:

1) Derived from the +12 V supply
2) Derived from the +24 V stand by voltage
3) Derived from the built-in battery

The function of the different components used in this circuit is as follows:
The +12 V on the p.c.b. is reduced to 5.7V via the voltage stabiliser D8 [K/11] and diode V9 [L/11].
The voltage on point 3 of D8 is lowered to 5 volt via the diode V8 [K/11]. This diode isolates the battery voltage and Uchar+ from the voltage stabilizer D8 when the normal power is switched off.
The diodes V1 and V3 isolate the battery from the Uchar, when this voltage is not present and the switch "Battery" is in the position "ON". If the switch is in the position "OFF" the battery is only isolated by V3.
The battery is charged via the resistor R9 and the charging current is about 7 mA. If no battery is connected the voltage at the junction of R9 and V2 is limited by V2 to 6.2Volt.

4.3.4.7. Level converter voltage

The level converter ic's on the bus interface p.c.b. need a voltage on pin 16 which must always be less than the voltage on pin 1. From the voltage which is connected with pin 1 of the level converter ics a voltage is derived for pin 16 via the zenerdiode V7 and resistor R19. This voltage is about 5V.

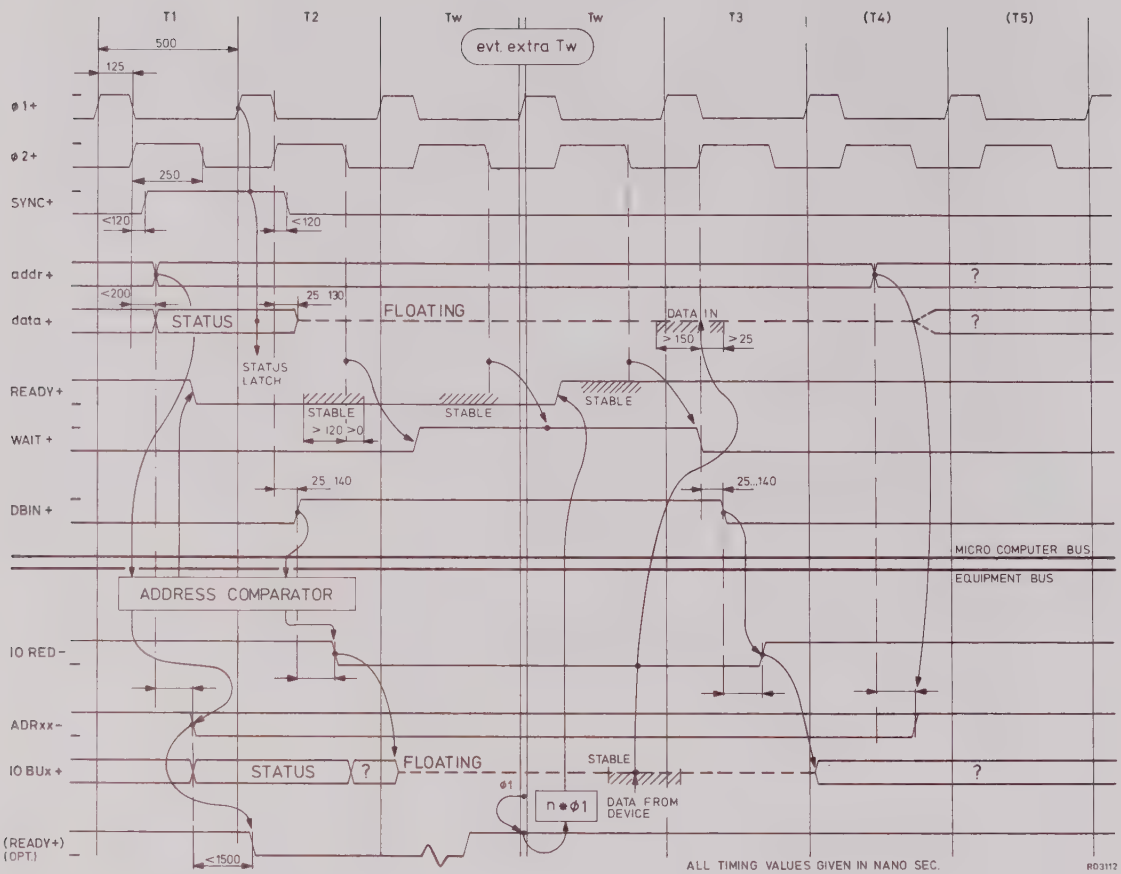


Fig. 4.3.4.3.1. Read cycle

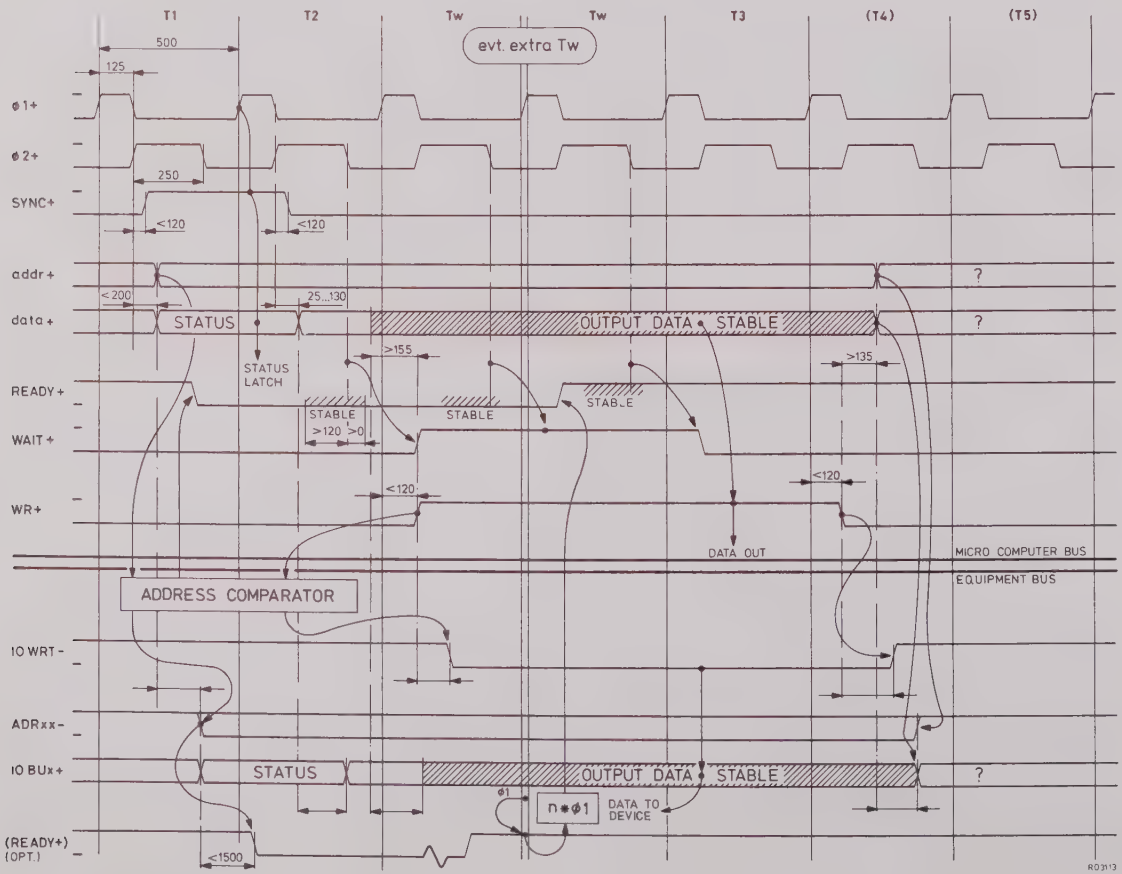


Fig. 4.3.4.3.2. Write cycle

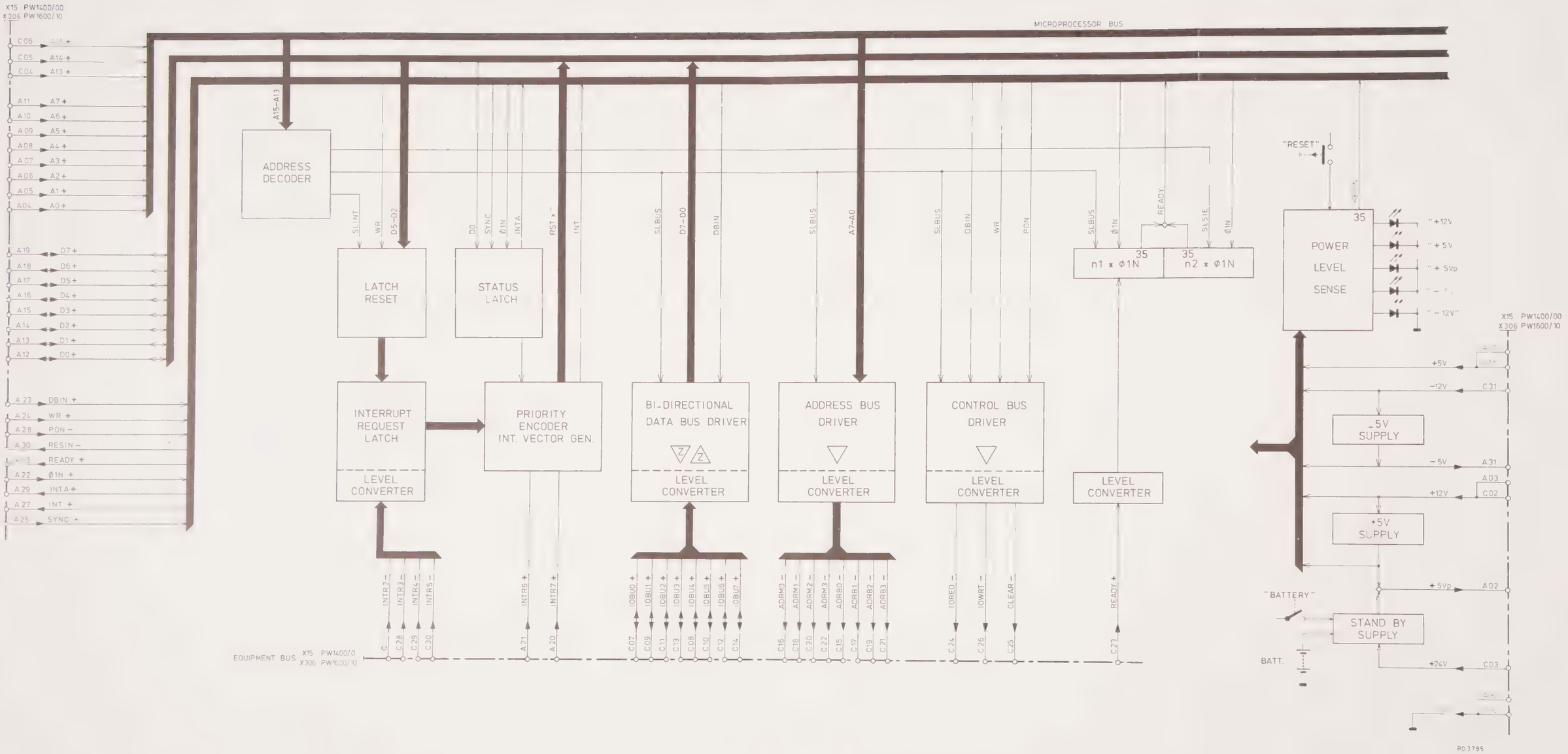


Fig. 4.3.4.1. Block diagram bus interface

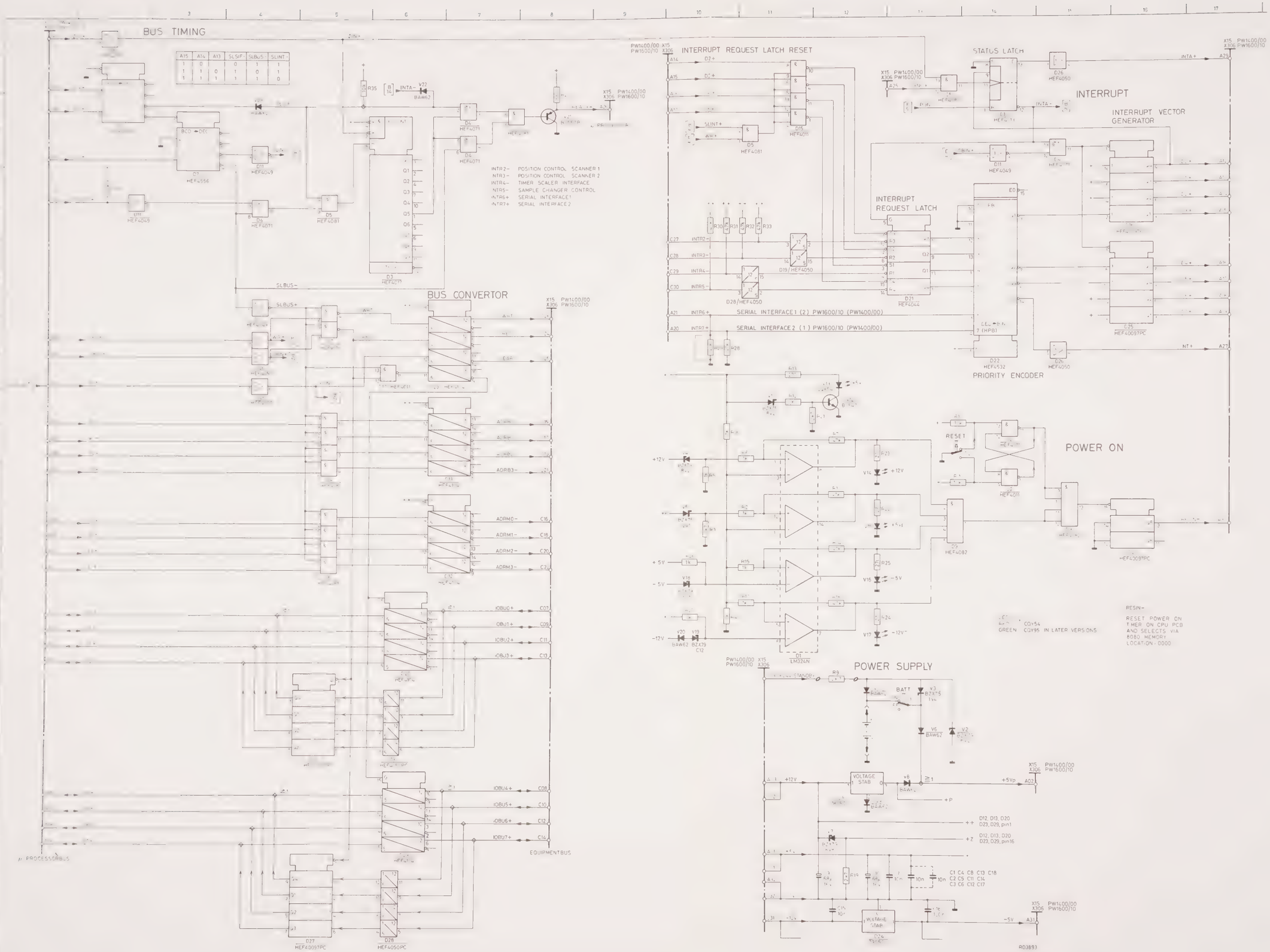


Fig. 4.3.4.2. Bus interface circuit diagram

4.4. MEASURING CHANNEL

4.4.1. Introduction

The measuring channel consists of five printed circuit boards each carrying a separate circuit as follows:

A1. Amplifier/ analyser 1 (for scintillation detector)

A2. Amplifier/ analyser 2 (for gas flow detector)

A3. Window control

A4. Ratemeter

A5. Counter/ timer

The signal and data flows in the measuring channel are shown in the block diagram fig. 4.4.1.

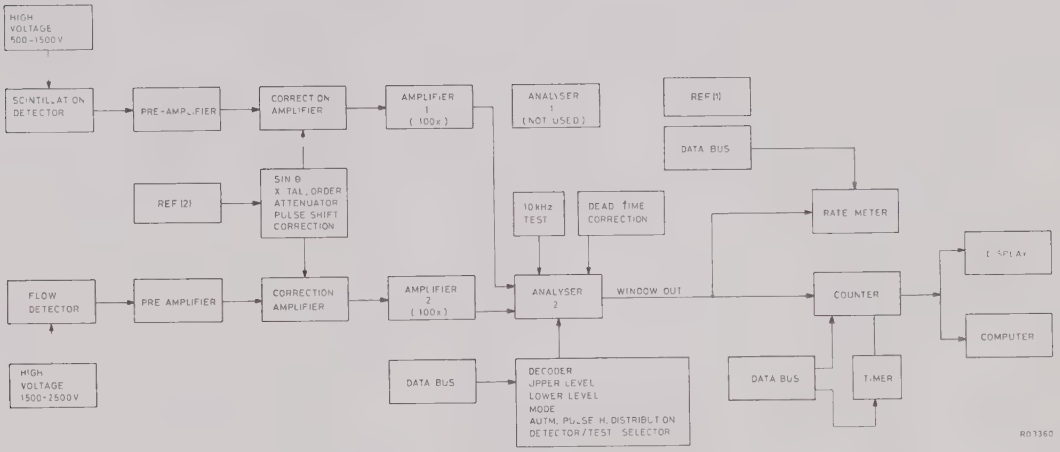


Fig. 4.4.1. Measuring channel block diagram

> **NOTE**
>
> The amplifier/analyser 1 and 2 printed circuit boards are identical and interchangeable for service purposes.

The scintillation detector and the gas flow detector are each connected to a separate amplifier/analyser circuit. The detector pulses are first corrected for the effects of sin θ, crystal "d" spacing, order of reflection, and pulse shift. The reference voltage circuit is present on both printed circuit boards, but that on pcb A2 is used for the common attenuator circuit, that on A1 not being used.

The corrected pulses are next amplified and fed to the analyser circuit on pcb A2. The analyser circuit is supplied with upper level and lower level and mode voltage levels from the window control circuit on pcb A3, and with a detector selection demand from the spectrometer control 1 pcb A8. The analyser circuit on p.c.b. A1 is not used.

The resulting pulses which pass the "window" are fed to the ratemeter pcb A4 and the counter/timer pcb A5. The ratemeter circuit converts the countrate to an analoque signal for display on a panel meter and on a chart recorder. The counter/timer pcb A5 counts the pulses passing the "window" in a predetermined time and provides outputs to displays of counts and time, and to a V24 interface to which a peripheral unit may be connected.

4.4.2. Detector HV supplies and preamplifiers

4.4.2.1. Introduction

The PW 1400/00 is provided with two stabilized high voltage supplies:

3kV max. for the gas-flow detector

1.5kV max. for the scintillation detector

The high voltage supplies are essentially similar, differing in the number of voltage-multiplier stages used (see fig. 4.4.2.1.).

An oscillator (astable multivibrator) is used to switch current alternately through two halves of a transformer primary winding. The voltage at the secondary side of the transformer is fed to a voltage multiplier, the output of which provides the high voltage for the detectors.

A fixed proportion of the output voltage is compared with an adjustable proportion of a stabilized reference voltage in a difference amplifier. The output of this amplifier provides a dc offset voltage which is applied to the centre-tap of the transformer primary winding, providing a means of adjusting the high voltage and at the same time of stabilizing the voltage.

The current and voltage delivered are continuously monitored. If the current or voltage limits are exceeded a safety circuit stops the oscillator and grounds the centre-tap of the transformer primary winding, switching off the high voltage.

The detector preamplifiers are also essentially similar, being based on identical charge amplifiers in the form of thin-film circuits.

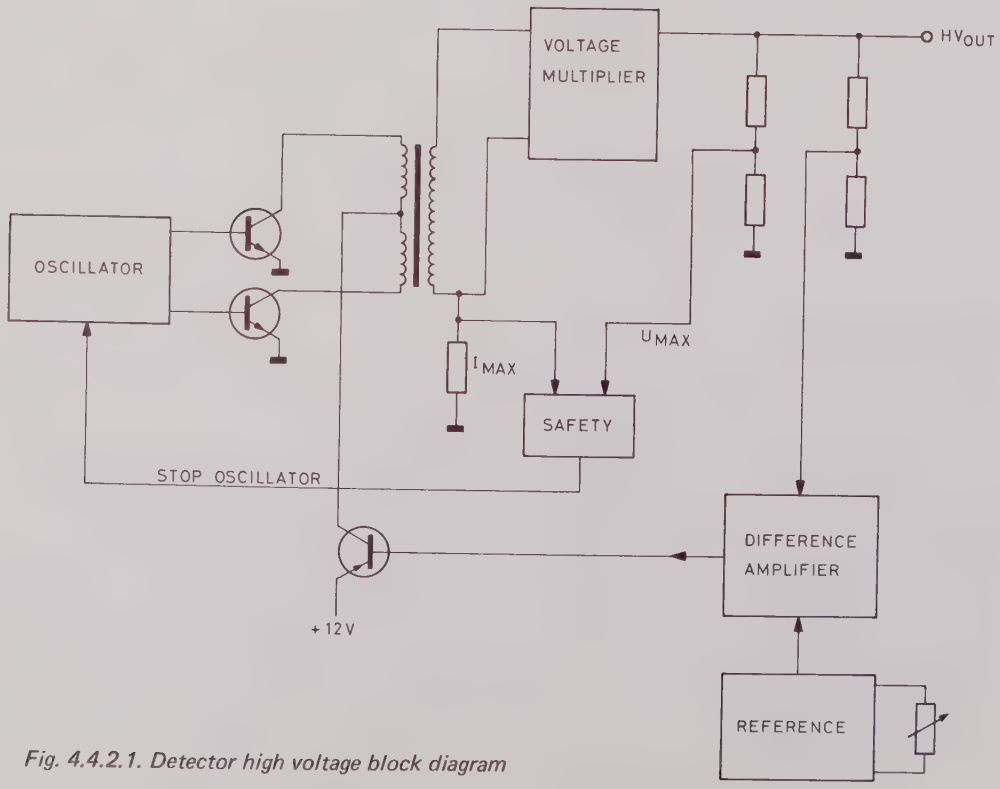


Fig. 4.4.2.1. Detector high voltage block diagram

4.4.2.2. Detector high voltage supplies (fig. 4.4.2.2.)

The oscillator consists of a timer D11 [J/2] connected as an astable multivibrator. The capacitor C_1 is charged until the voltage across it reaches 2/3 of the supply voltage (charging time τ_1 = [R1+R2+R3) C1] . At this point the capacitor discharges via D1—7 until the voltage across it has dropped to 1/3 of the supply voltage (discharging time τ_2 = R3. C1), when the cycle is repeated.

The pulse train thus produced from D1—3 is applied to a counter, the outputs from stages Q0 and Q2 of which are used to switch the transistors V5 and V6 alternately. The output from stage Q4 resets the counter. The switching frequency of the transistors is approximately 25 kHz.

The transistors V5 and V6 cause a chopped direct current to flow alternately in the two halves of the primary winding of the transformer T1 in opposite directions.
The voltage induced in the secondary winding is multiplied by the diode/capacitor circuit and the rectified voltage so produced is fed to the output.

The output voltage is also fed, via the neon indicator V27 and the diode V21 to the emitter of V9. A voltage proportional to output current appears across the diode V19 and this is also fed, via the diode V20, to V9. If either the current or the voltage limit is exceeded the voltage level at D1 pin 4 will go low, stopping the oscillator. This low level is also fed to the base of V8, causing it to switch off. The resulting high level at the base of V7 switches this transistor off, resulting in an open circuit at the centre tap of the primary winding of T1, and preventing any possible current flow.

4.4.2.3. Calibration

WARNING

This procedure involves working on a pcb on which up to 3kV is present at several places. For all adjustment use plastic trimming tools and stand on an insulating mat.

(a) Switch off the mains supply to the spectrometer

(b) Disconnect the high voltage supply to the detector at the BNC connector X42 or X43 as appropriate.

(c) Remove the HV pcb and reconnect it using an extender card.

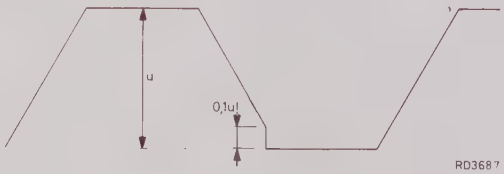
(d) Connect a load resistor of 30 megohms, 1 watt, between connector pins C18 and C24 on X40 or X41 as appropriate.

(e) Set the high voltage adjustment potentiometer on adjustment panel 2 on the spectrometer (R32 or R33 as appropriate) to its maximum setting (i.e. 3000V or 1500V).

(f) Rotate the potentiometers R23 and R26 on the pcb totally counter clockwise.

(g) Connect a high voltage meter (Range 3kV, input restance $\geqslant 30$ megohms) to the output pins C18 and C24 and switch on the mains supply.

(h) Connect an oscilloscope to the collector of V5 or V6 and check that the following signal trace is observed:



If this signal form is observed no saturation or unwanted oscillation of the transformer will be present.

If this signal form is not observed adjust the oscillator potentiometer R2 [1/2] until it is.

(j) If the output voltage is not 3000 V, (or 1500 V as appropriate) change the value of R43 [B/11] until 3000 V is obtained.

(k) Measure the voltage on the cathode of V23 [F/6] with the oscillospe and record it.

(l) Adjust R23 [E/8] until the peak value of the voltage on the anode of V20 [E/8] as measured with the oscilloscope is the same as that found in (k). This sets I max.

(m) Adjust R26 [E/9] until the peak value of the voltage on the anode of V21 [E/9] as measured with the oscilloscope is the same as that found in step (k). This sets U max.

(n) Connect a capacitor of 10n 3 kV to pin C18 and check the ripple on the output. This must be less than 10 mV.

4.4.2.4. Potentiometers 1500V (1x) and 3000V (2x).

If, for any reason, the dials are removed from these potentiometers they must be replaced correctly to ensure that calibration is not lost.

Before replacing a dial, switch off the mains supply to the spectrometer. Turn the potentiometer fully clockwise by hand, turn the dial clockwise until it reads 1500, and fasten the dial in position.

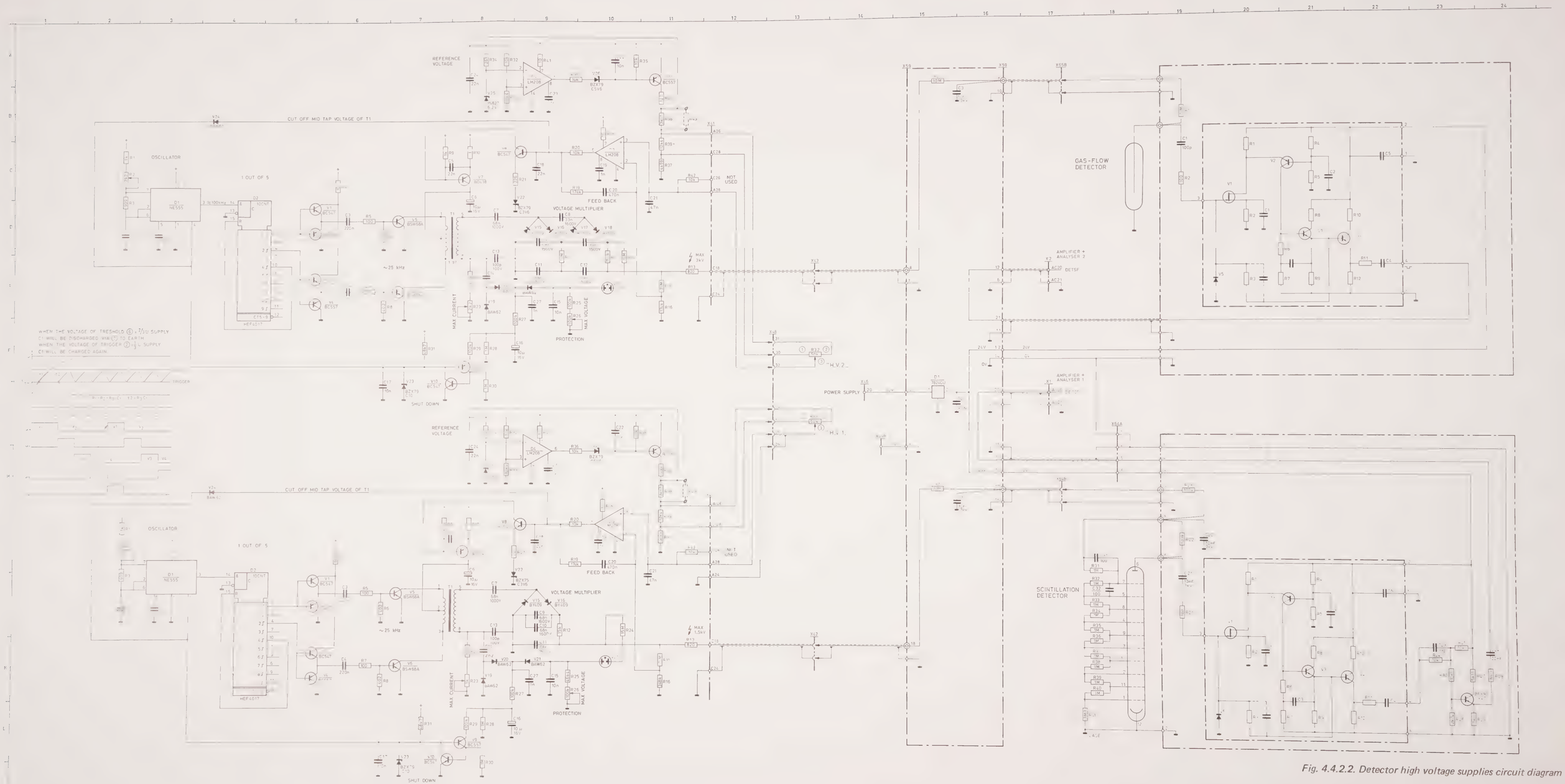


Fig. 4.4.2.2. Detector high voltage supplies circuit diagram

4.4.3. Amplifier/Analyser

4.4.3.1. Introduction

The amplifier/analyser performs several basic functions (see block diagram, fig. 4.4.3.2.):

1. It corrects the pulse height to account for crystal "d" spacing, order of reflection, and sin θ
2. It corrects for pulse shift which occurs at high count rates.
3. It amplifies the pulses by a predetermined amount.
4. It provides switching for detector selection.
5. It provides a pulse height analyser in the form of variable upper and lower levels (thresholds).
6. It converts incoming pulses from an analoque to a digital form.
7. It introduces a correction for dead-time losses.

In practice two identical and interchangeable printed circuit boards are fitted in the spectrometer, one for each detector.

4.4.3.2. Correction amplifier

Analogue pulses from the detector preamplifier are fed to a correction amplifier where they are multiplied by two correction factors "A" and "B".

Correction factor "A" [8/11] is a value which depends on the position of the ATTENUATION switch, the "d" spacing of the programmed crystal and the programmed order of reflection (supplied by the microprocessor via the data bus), and sin θ (a voltage level derived from the sin θ potentiometer).
The reference voltage for this circuit is situated on the amplifier/analyser pcb (V8, D23, on fig. 4.4.3.2.).
For both detector signal circuits the reference voltage on amplifier/analyser 2 pcb is used.

Correction factor "B" [D/13] is a factor which compensates for the shift in pulse amplitude which occurs at high count rates, and effectively results in the mean pulse height being adjusted to the ideal level.

During calibration the detector high voltage and the amplifier attenuation must be adjusted so that the whole span of the pulse shift correction is available for use. This is arranged by switching the pulse shift correction circuit out and substituting a fixed value of −4V via V36, R90 and R91.
(fig. 4.4.3.2. K/34). The correction range available is −10% to + 100% of this fixed value (i.e −3.5V to −8.5V)

In a similar way the correction factor "B" is fixed at −4V for low count rates via D16−7 (fig. 4.4.3.2. H/32).

During automatic pulse height distribution scans the pulse shift correction circuit is also switched out, but in this case factor "B" is a voltage level derived from the previous measurement and stored in capacitors C4 and C5 (fig. 4.4.3.2. E/8)

4.4.3.3. 100x Amplifier and zero line restorer.

The pulses from the correction amplifier (pulses x "A" x "B") are fed to the two-stage 100x amplifier. The amplification factor is given by R17/R10 and R24/R20 (fig. 4.4.3.2. C/15, D/17).

This amplifier is also provided with a zero line restorer D16, D21, etc (fig. 4.4.3.2. E/16, E/18).
If, at the output of the amplifier the pulses are superimposed on a dc level (i.e. are not refered to the correct zero level), it is important that this be corrected.

One side of capacitor C12 is maintained at earth potential by the "ideal diode" formed by V5, D21, etc. Only the pulse passes C12, while dc level appears accross C12. This dc level is fed back to the input of the amplifier via the integrator D16, the filter R34, C16, and the jumper "B", where it is subtracted from the input pulse. Thus the pulse is effectively referred to the original zero value.

4.4.3.4. Pulse shift correction.

Pulses leaving the amplifier are fed to the pulse shift correction circuit. This circuit consists of two "windows" one above the other with one common level. The common level is aranged to be at 50% of the range of the analyser, so that when the mean pulse height is also at 50% of the range exactly half of the pulses leaving the amplifier will pass through each of the "windows". The pulses passing each window are fed to a ratemeter, and the outputs of the ratemeters (D25, D26, fig. 4.4.3.2. K/30) are compared.
If the two outputs are not equal at the input to the difference amplifier D16–1 then the current sources V33 and V34 are activated, changing the charge on capacitors C4 and C5 (fig. 4.4.3.2. E/8).
This results in a change in factor "B".

If the push-button CALIBRATE is pressed this results in signal CALBR– = 0, fixing factor "B" at –4V via V36 (fig. 4.4.3.2. K/34) At low countrates factor "B" is also fixed at –4V via difference amplifier D16–7.

When an automatic pulse height distribution is being made signal PHDIV + = 1 causes the whole pulse shift correction circuit to be switched out via V37 and V35 (fig. 4.4.3.2. H/34). The correction voltage which applied to the previous measurement is used for correction, since this voltage is "remembered" by capacitors C4 and C5 (fig. 4.4.3.2. E/8).

4.4.3.5. Pulse height analyser.

Pulses leaving the amplifiers are passed to the detector switches D19–1 and D19–9 (fig. 4.4.3.2. F/9 and K/9). These FET switches are controlled by signals SLFCD + and SLSCD + from the spectrometer control 1 pcb, and enable the pulses from each detector to be accepted separately or the pulses from both detectors to be added together.

On the pcb is a two position switch S1 (figure 4.4.3.2. M/8) which enables a 10kHz test signal from the counter-timer pcb to be applied to the discriminator in place of the detector pulses.

The discriminator consists of two pairs of difference amplifiers, supplied with variable reference voltages from the window control pcb. The reference voltages cause the difference amplifiers to act as thresholds, one representing the upper level and one the lower level. A block diagram of one discriminator circuit is shown in fig. 4.4.3.5.

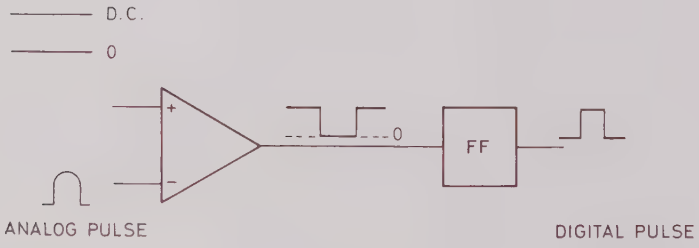


Fig. 4.4.3.5. Discriminator block diagram

> **NOTE**
>
> The two amplifier/analyser pcbs are identical but the analyser section of amplifier/analyser 1 is not used.

The pulse height analyser can operate in several different modes:

1. Usually only pulses of a particular energy level (wavelength) are required to be counted. In this case both discriminators are used, the pulses passing the upper level being subtracted from the pulses passing the lower level. The resultant pulses fed to the counter circuit are therefore only those which have a pulse height between the lower and upper levels (the so called "window").
2. If, for example, a scan is to be made it is then normally required to count all pulses which pass the lower level (an ∞ window")

3. A very narrow "window" (e.g. 2% of the total window range) can be used to scan the whole pulse height range, the pulses passing the window being used to record the "pulse height distribution".

   Pulses passing the upper level set the flip-flop D12-8, D13-8 and after being delayed in D15-3 and D15-6 are presented to one input of D7-6. Pulses passing the lower level set the flip-flop D12-11, D13-12, trigger the dead-time one-shot D14, and are presented to the other input of D7-6. Owing to the built-in delays and the one-shot these components act as an anticoincidence circuit , the only pulses passing D7-6 being those which are above the lower level and below the upper level, (i.e. in the "window"). This delay is necessary because the lower level flip-flop is triggered earlier than that for the upper level. (See fig. 4.4.3.7. discriminator pulse diagram)

4.4.3.6. Dead-time correction

For a short period after a pulse has been produced in a detector the detector is effectively saturated and can not accept a further pulse.
This is the so called "dead-time" of the detector , and varies slightly between detectors. For this reason a fixed dead-time, longer than that of the detector is built-in to the circuit.
This dead-time is provided by a one-shot D14 (fig. 4.4.3.2. H/12) and is fixed at 300ns, i.e. after a pulse has been accepted no further pulse will be accepted for 300ns.

Since the production of X-ray quanta, and therefore detector pulses, is a random process, provided sufficient pulses are counted, the number of pulses which occur during the dead-time can be calculated statistically. This number of pulses is produced in the dead-time correction circuit and added to the detector pulses to obtain the true countrate.

If it is assumed that all the pulses with pulse heights below the lower level are caused by noise (and can therefore be neglected), and if N_w = true countrate in the "window"

N_w1 = actual countrate in the "window"

N_{ll} = pulses with pulse heights above the lower level

τ = dead-time

then: The fraction of time for which the system is dead is:

$$N_{ll}\,\tau$$

(eg at 100 000 c/s, with τ = 300 ns, the system will be dead for 3% of the time),

and the fraction for which it will be open is

$$1-N_{ll}\tau$$

$$\text{So } N_w = \left(\frac{1}{1-N_{ll}\tau}\right) N_{w'}$$

$$= \frac{N_{w'}}{1-N_{ll}\tau}$$

$$= N_{w'} + N_{ll}\,N_w\,\tau$$

The corrected pulses (WWOUT) are fed to the ratemeter and counter/timer circuits.

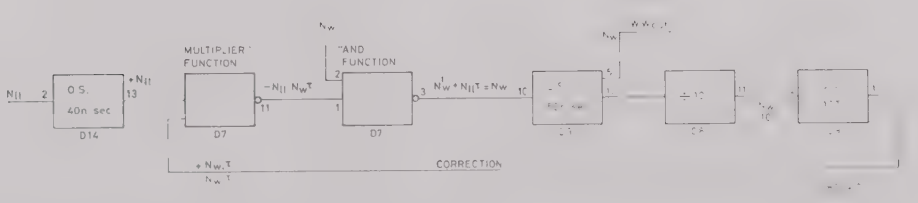


Fig. 4.4.3.6. Deadtime correction block diagram

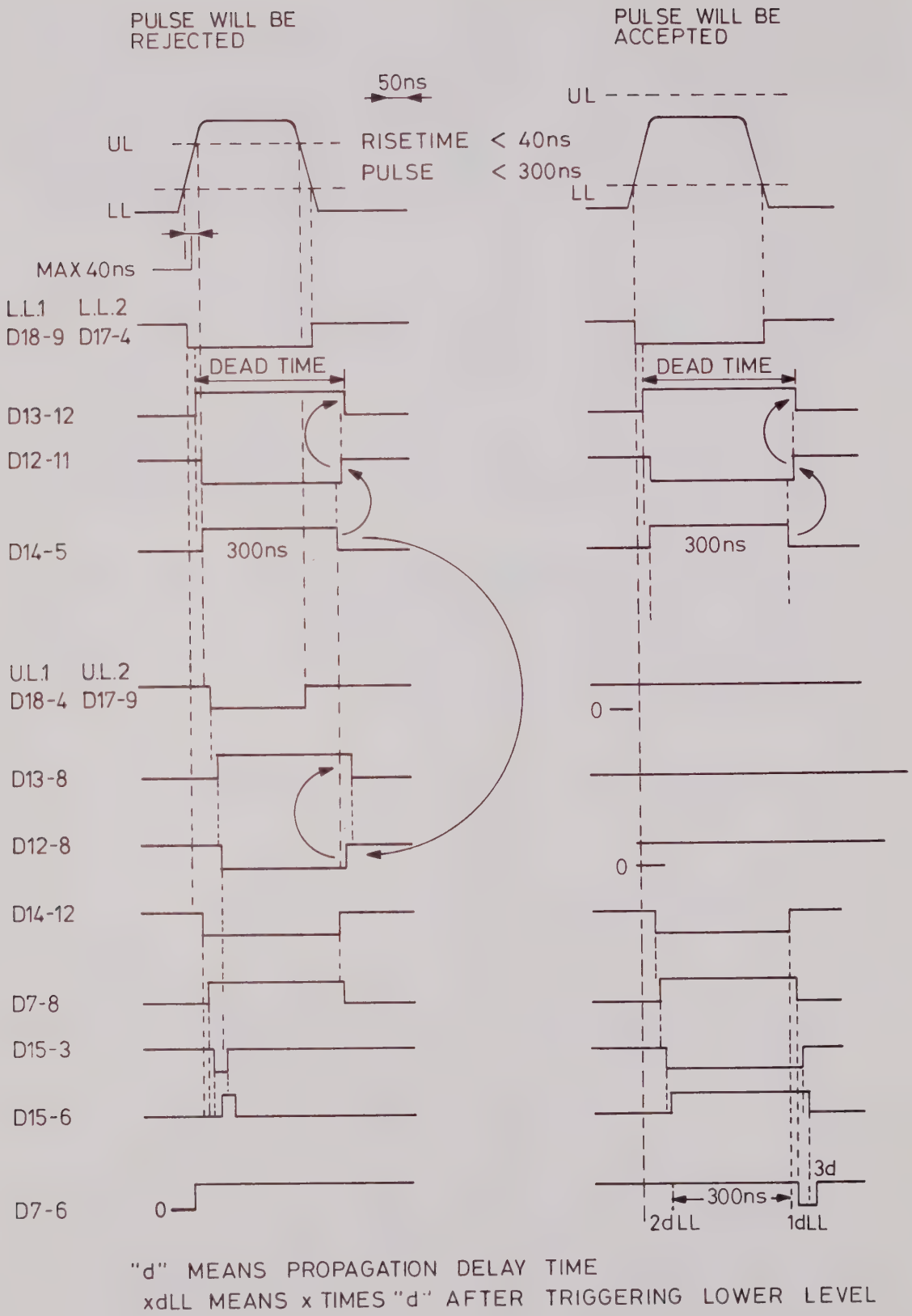


Figure 4.4.3.7. Discriminator circuit pulse diagram

RD 5113

AMPLIFIER ANALYSER 2

MULTIPLIER

100 x AMPLIFIER

OUTPUT = "A" x "B" x "PULSE"

PULSE INPUT

PULSE SHIFT CORRECTION

DISCRIMINATOR

ZERO LINE RESTORER

SUBTRACT DC PRESENT ON C15 DUE TO ZERO LINE SHIFT

ADDING WHEN USING 2 DETECTORS

TIME DELAY

DEAD TIME ONE SHOT 1t

MEASURE

DEAD TIME CORRECTION

DISCRIMINATOR LEVEL
AMPLIFIER OUT ANALOG PULSE
OUTPUT DISCRIMINATOR (DIGITAL PULSE)
DEAD TIME ONE SHOT MULTVIB
LOWER LEVEL PULSES
AFTER EVERY 10 PULSES
RESULT (D7-12+D7-13)
WINDOW PULSES
EXTRA PULSE
CORRECTED REAL COUNT RATE
NORMALISED CORR COUNT RATE
DURING "8" AND "9" REACTS ON LEADING EDGE SO DIVIDES BY 10

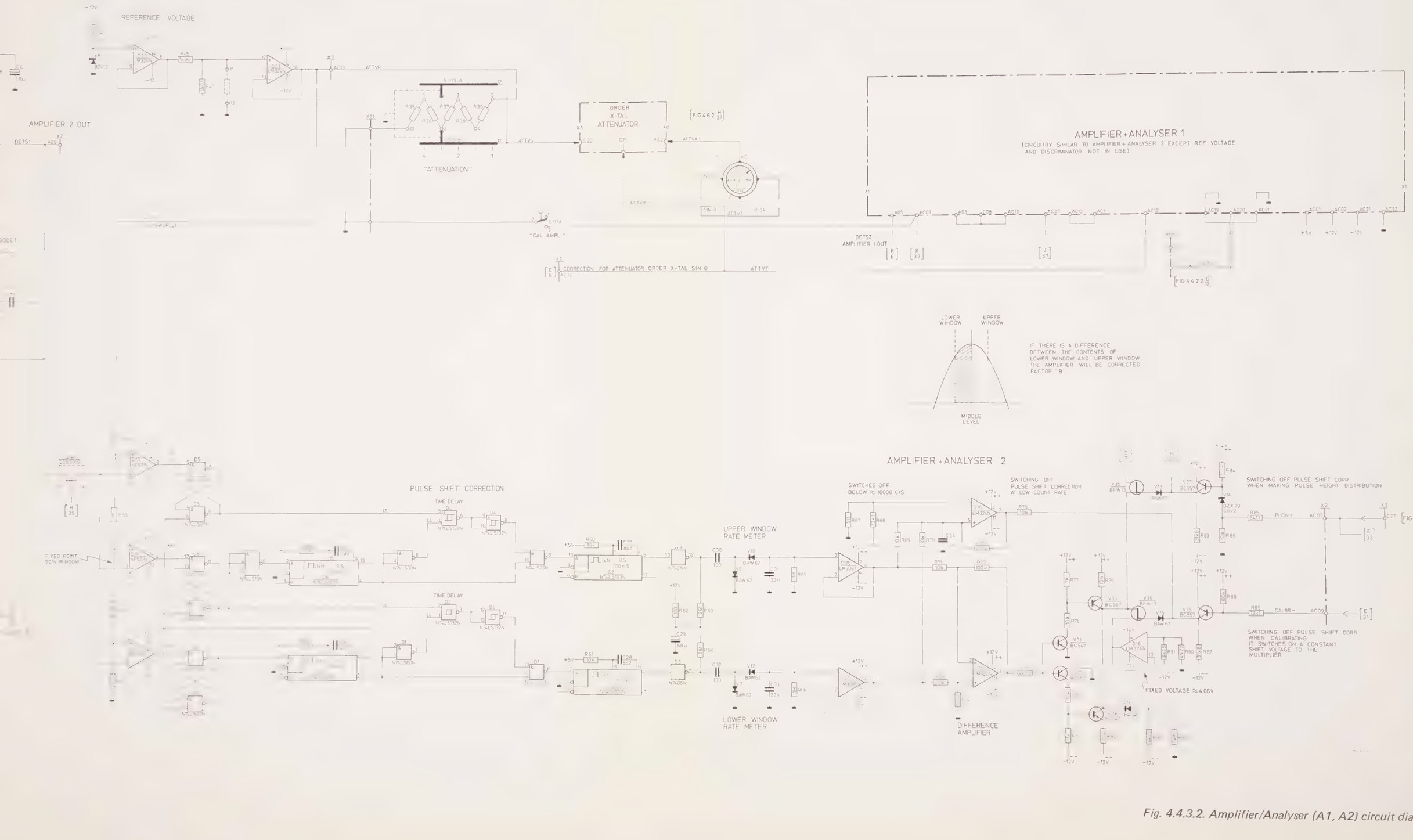


Fig. 4.4.3.2. Amplifier/Analyser (A1, A2) circuit diagram.

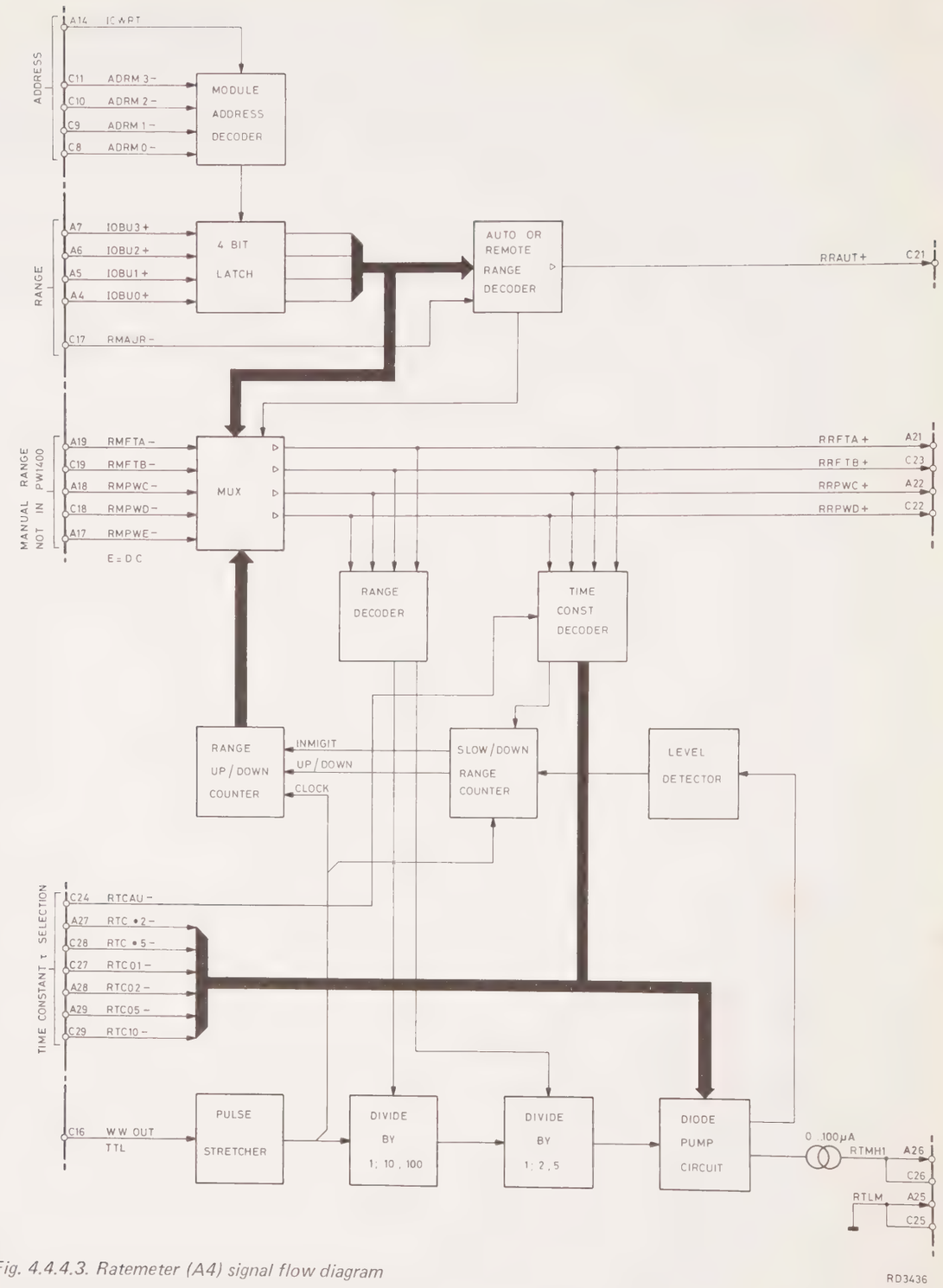


Fig. 4.4.4.3. Ratemeter (A4) signal flow diagram

4.4.4. Ratemeter

4.4.4.1. Introduction

The ratemeter integrates the pulses from the amplifier/analyser for a time determined by the TIME CONSTANT control switch. The resultant output can be displayed on the meter (100 μA FSD) on the front panel of the PW 1400/00 or on an external chart recorder (100 mV FSD, Ri > 100 kΩ for 1% accuracy).

The range of the ratemeter is determined by information on the data bus. Although the circuit provides for manual range setting, this facility is not used in the PW 1400/00. Auto ranging is also possible with this circuit.

The time constant of the ratemeter, which affects both the meter and chart recorder readings, is set with the switch S112, TIME CONSTANT, on adjusting panel 2 at the right-hand side of the spectrometer. The best setting for this switch depends on the countrate, the recorder chart speed, and the goniometer scanning speed.

4.4.4.2. Address and Data Inputs (see fig. 4.4.4.2.)

Ratemeter card address = /5

Byte address = not used

Input/output bus lines D7–D4 = not significant

Input/output bus lines D3–D0 = range data

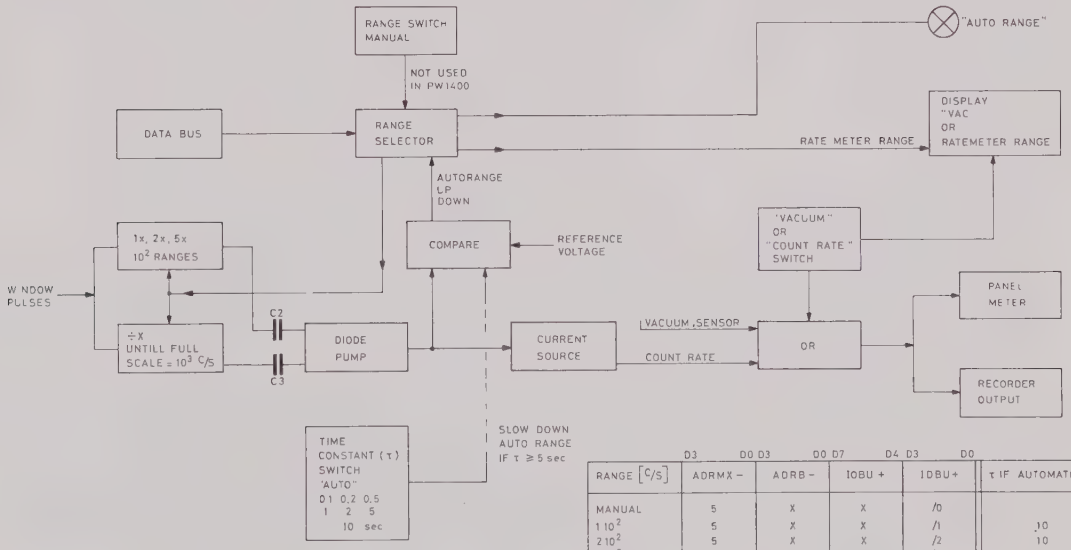


Fig. 4.4.4.2. Address and data bus lines

	D3	D0 D3	D0 D7	D4 D3	D0	
RANGE [C/S]	ADRMX –	ADRB –	IOBU +	IDBU +	τ IF AUTOMATIC [S]	
MANUAL	5	X	X	/0		
$1\,10^2$	5	X	X	/1	10	
$2\,10^2$	5	X	X	/2	10	
$5\,10^2$	5	X	X	/3	10	
AUTO	5	X	X	/4	DEPENDS ON RANGE	
$1\,10^3$	5	X	X	/5	10	
$2\,10^3$	5	X	X	/6	5	
$5\,10^3$	5	X	X	/7	2	
	5	X	X	/8		
$1\,10^4$	5	X	X	/9	1	
$2\,10^4$	5	X	X	/A	0.5	
5.10^4	5	X	X	/B	0.2	
	5	X	X	/C		
$1\,10^5$	5	X	X	/D	0.1	
$2\,10^5$	5	X	X	/E	0.1	
$5\,10^5$	5	X	X	/F	0.1	

BE CAREFUL ADRMX- NEG LOGIC "0" = H
IOBU + POS LOGIC "1" = H

RD 3365

NOTE
The front panel meter and the chart recorder can be used to monitor the vacuum level if the push-button switch VACUUM (S 103) is depressed. The LED display will then show "VAC".
Ensure that the push-button switch COUNTRATE is depressed for operation in ratemeter mode.

4.4.4.3. Ratemeter ranges and time constants

The operating range is selected by the microprocessor via the IOBU lines. The ranges available are 10^2 to 5.10^5 c/s in twelve steps weighted 1, 2, 5.

Autoranging can also be selected with ranges available from 5.10^2 to 5.10^5 c/s in 10 steps.

The time constant τ can be manually selected from 0,1 to 10 seconds in seven steps weighted 1, 2, 5, or automatic. If automatic time constant is selected for the ranges 5.10^2 to 1.10^5 c/s , this will be adjusted so that: Range $x\tau = 10^4$ in all cases.

* For the other ranges see fig. 4.4.4.4.

4.4.4.4. Autoranging. (Fig. 4.4.4.3 and Fig. 4.4.4.4)

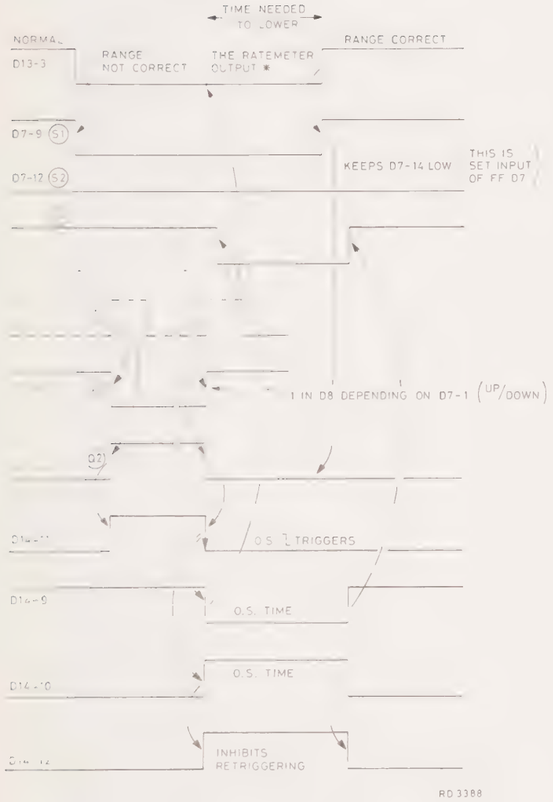
Input	–	Pulses	– Amplitude 5V (TTL level)
			Pulse width > 50 ns
Output	–	dc	– 0 – 100 μA
Inaccuracy	–		< ± 2%
Nonlineartity	–		< ± 2%

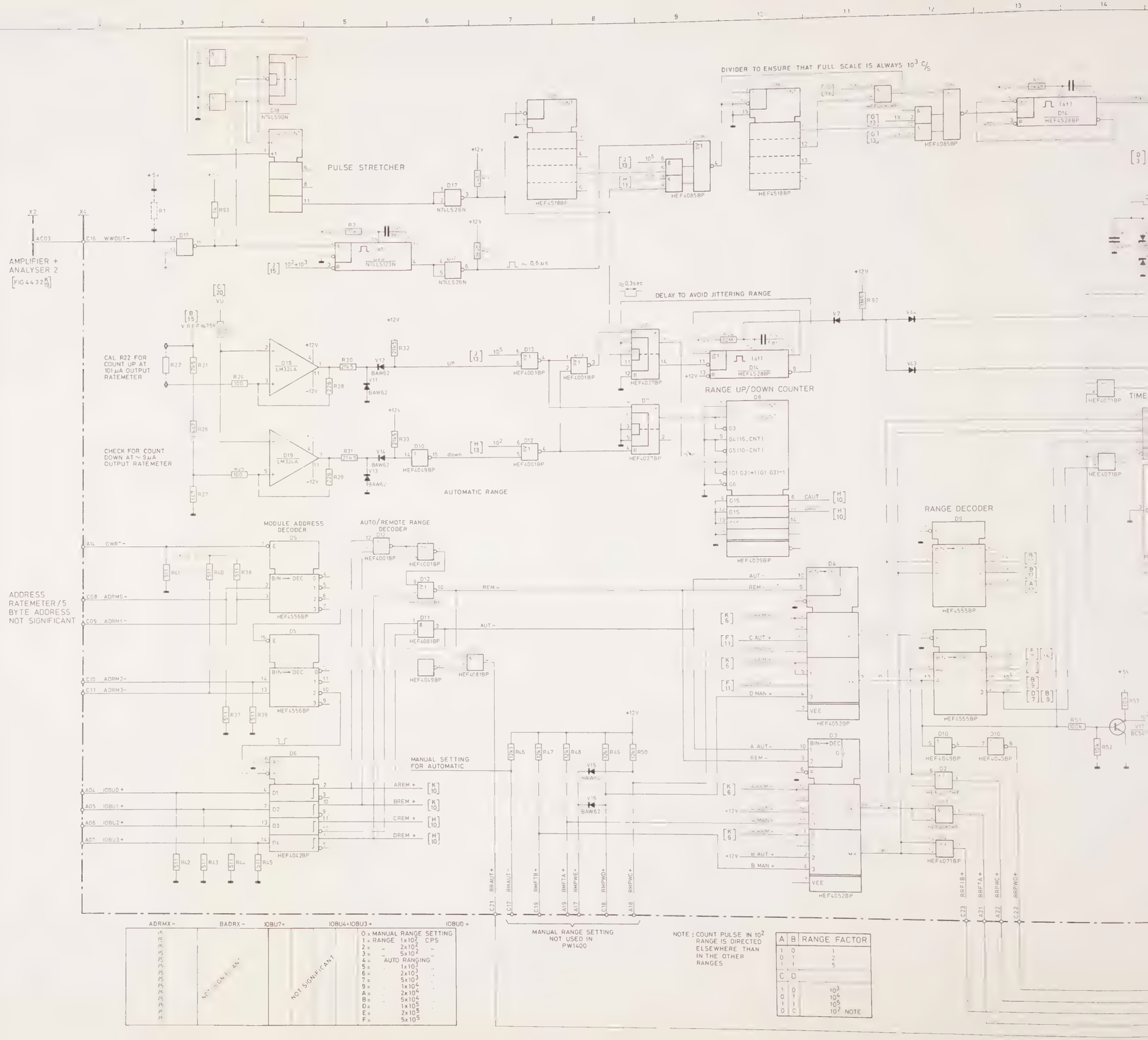
In principle the ratemeter is a capacitor charged to a certain dc level (VU). This level is translated into a current which is fed to a panel meter via two series resistors R84 and R87 (fig. 4.4.4.4. H/28). Accross these resistors appears 0 – 100mV which is fed to an external chart recorder.

A reference voltage (≈ 7.5V) is produced by V8 (fig. 4.4.4.4. B/15). The dc level (VU) is compared with this dc level in D19–1 and D19–7 (E/4). If the reading on the meter is more than 1x (>100% reading) the signal UP– will be produced, while if it is less than 0.1x (< 10% reding) the signal DOWN – will be produced. These signals are fed to the range up/down counter D8 (F/10) via NOR gates, D12–4 for the lower range (10^2 c/s) and D13–4 for the upper range (10^5 c/s). The one-shot D14–9 (E/10) delays the action to avoid the jittering which would otherwise result because of the time constant of the ratemeter. Two different delays are used in relation to time constant.
The time constant is determined by the level of the lines (1), (2), and (3) (fig. 4.4.4.4. D/16) as follows:

Mode	Range	τ	Line	Junction V43 V, V44
Manual		1 s	(2) = low	low
		1 s	(3) = low	low
Autoranging	1., 2., 5.10^2	1 s	(1) = low	low
	1.10^3	1 s	(2) = low	low
	$2x10^3$	1 s	(3) = low	low
All other cases		0,3 s		high

If the junction of V43 and V44 is low the time constant of the one-shot D14–9 will be determined by R34 and C9 (10 seconds). If the junction is high the time constant will be determined by R34 and R92 in parallel and C9 (5 seconds).


TIME NEEDED TO LOWER
NORMAL
D13-3
RANGE NOT CORRECT
THE RATEMETER OUTPUT *
RANGE CORRECT
D7-9 (S1)
D7-12 (S2)
KEEPS D7-14 LOW
THIS IS SET INPUT OF FF D7
1 IN D8 DEPENDING ON D7-1 (UP/DOWN)
Q2
D14-11
O.S. TRIGGERS
D14-9
O.S. TIME
D14-10
O.S. TIME
D14-12
INHIBITS RETRIGGERING
RD 3388


PULSE STRETCHER
DIVIDER TO ENSURE THAT FULL SCALE IS ALWAYS 10^3 C/S
AMPLIFIER + ANALYSER 2
[FIG 44 32 K 18]
VU
CAL R22 FOR COUNT UP AT 10 µA OUTPUT RATEMETER
CHECK FOR COUNT DOWN AT ~ 9 µA OUTPUT RATEMETER
DELAY TO AVOID JITTERING RANGE
RANGE UP/DOWN COUNTER
AUTOMATIC RANGE
MODULE ADDRESS DECODER
AUTO/REMOTE RANGE DECODER
RANGE DECODER
ADDRESS RATEMETER / 5 BYTE ADDRESS NOT SIGNIFICANT
MANUAL SETTING FOR AUTOMATIC
MANUAL RANGE SETTING NOT USED IN PW1400
NOTE : COUNT PULSE IN 10^2 RANGE IS DIRECTED ELSEWHERE THAN IN THE OTHER RANGES
ADRMX − | BADRX − | IOBU7+ | IOBU4+IOBU3+ | IOBU0+
NOT SIGNIFICANT
0 = MANUAL RANGE SETTING
1 = RANGE 1x10^2 CPS
2 = " 2x10^2 "
3 = " 5x10^2 "
4 = AUTO RANGING
5 = 1x10^3 "
6 = 2x10^3 "
7 = 5x10^3 "
9 = 1x10^4 "
A = 2x10^4 "
B = 5x10^4 "
D = 1x10^5 "
E = 2x10^5 "
F = 5x10^5
A | B | RANGE FACTOR
0 0 1
0 1 2
1 1 5
C D
1 0 10^3
0 1 10^4
1 1 10^5
0 0 10^2 NOTE

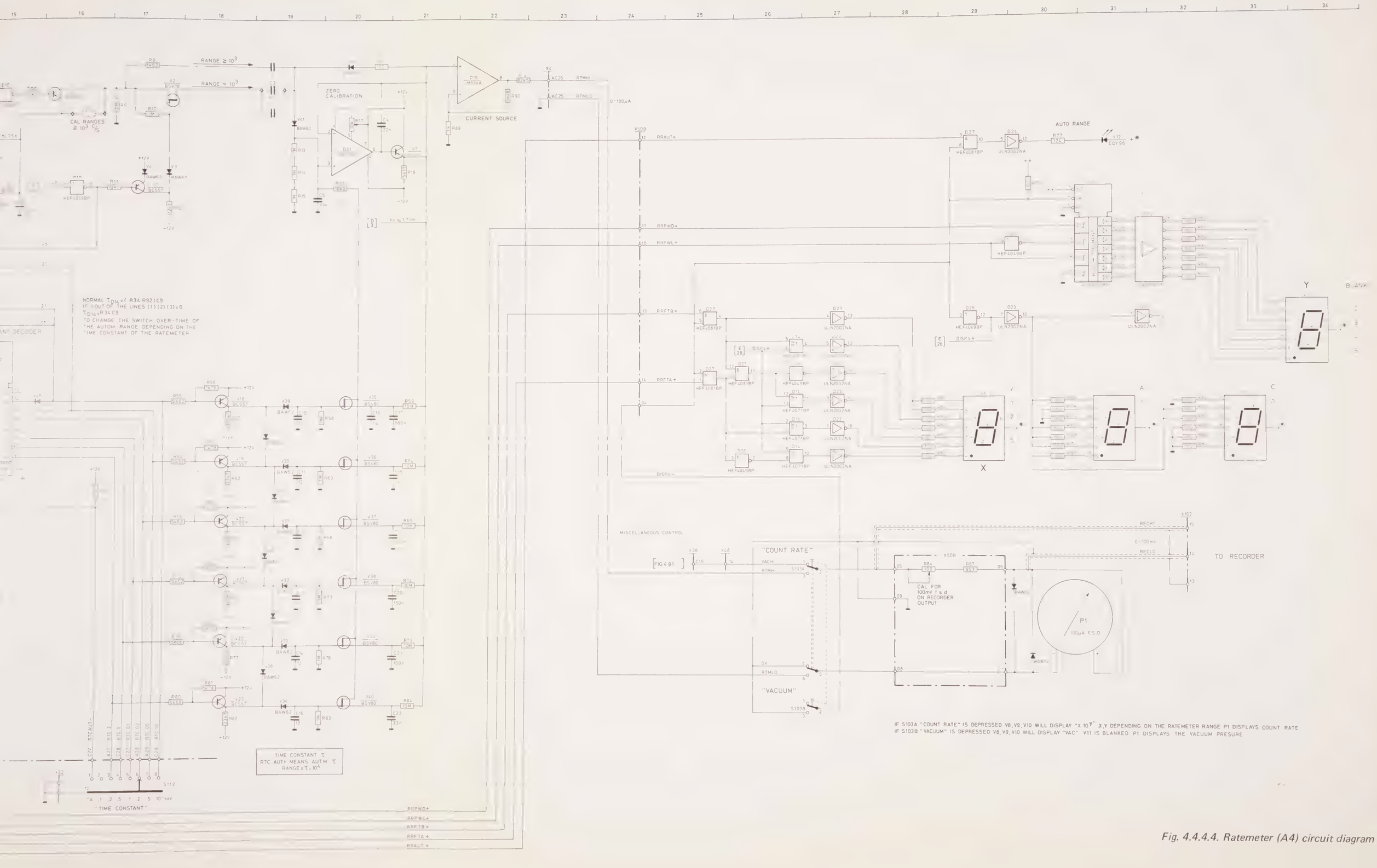


Fig. 4.4.4.4. Ratemeter (A4) circuit diagram

4.4.4.5. Calibration

The scale of the panel meter runs from 0 to 1000.
In order to be able to display several different ranges on this scale the pulse train is divided in such a way that the meter displays full scale deflection for each range.
The actual range in use is indicated on the LED RANGE display.

There is a slight difference in the way that the ranges $< 10^3$ and $\geqslant 10^3$ are calibrated, so that calibration must be done in two stages.

(a) Ranges $\geqslant 10^3$ c/s
Select value of R7 to give full scale deflection [B/16].

(b) Ranges 1, 2, 5.10^2 c/s
Connect suitable capacitor in parallel with C3 to give full scale deflection.
10pF/μA output on meter (100μA = full scale deflection).

(c) Autoranging

Select value of R22 (fig. 4.4.4.4. E/3) to give UP– pulse at output D19–1 at $\approx$ 110 μA on meter

Check that DOWN– pulse occurs at output D19–7 at $\approx$ 9 μA on meter.

The output to the recorder is calibrated with potentiometer R48 (Fig. 4.4.4.4. H/28). This potentiometer is located on the back of the display pcb, A50, and to reach it, it is necessary to first remove the table top.

4.4.5. Counter/Timer (fig. 4.4.5.1., 4.4.5.2., 4.4.5.3.)

4.4.5.1. Introduction

In the counter/timer addressable latches are used to store preset values of counts and time, the outputs of these latches being fed to comparators. While the counter/timer is running the contents of the counter and the timer are also fed to the comparators. Depending on the mode selected (preset counts or preset time) as determined by the appropriate address bits, an EQUAL signal will be produced at the output of the comparators when the contents of the latches and the counter or timer are equal.
This signal causes the counter and timer to be stopped. The results appear on the I/0 bus and, depending on the push-button selected on the spectrometer front panel, one of these results may also be displayed.

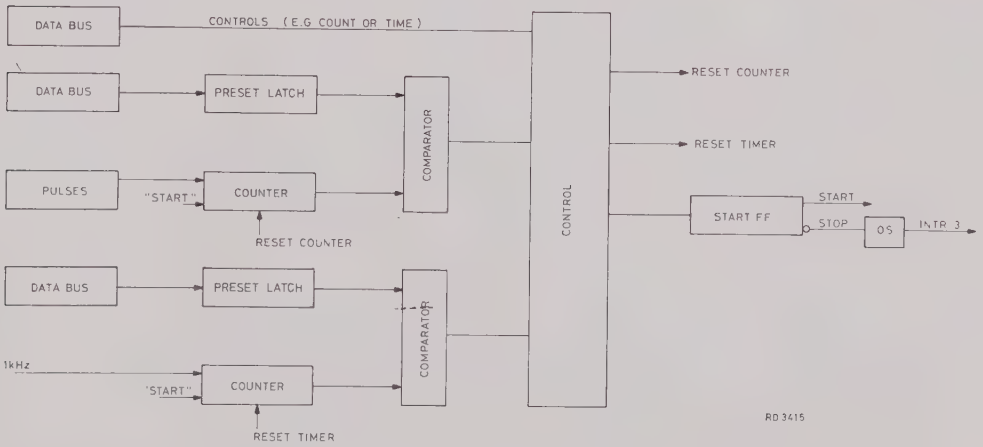


Fig. 4.4.5.1. Counter/Timer (A5) block diagram

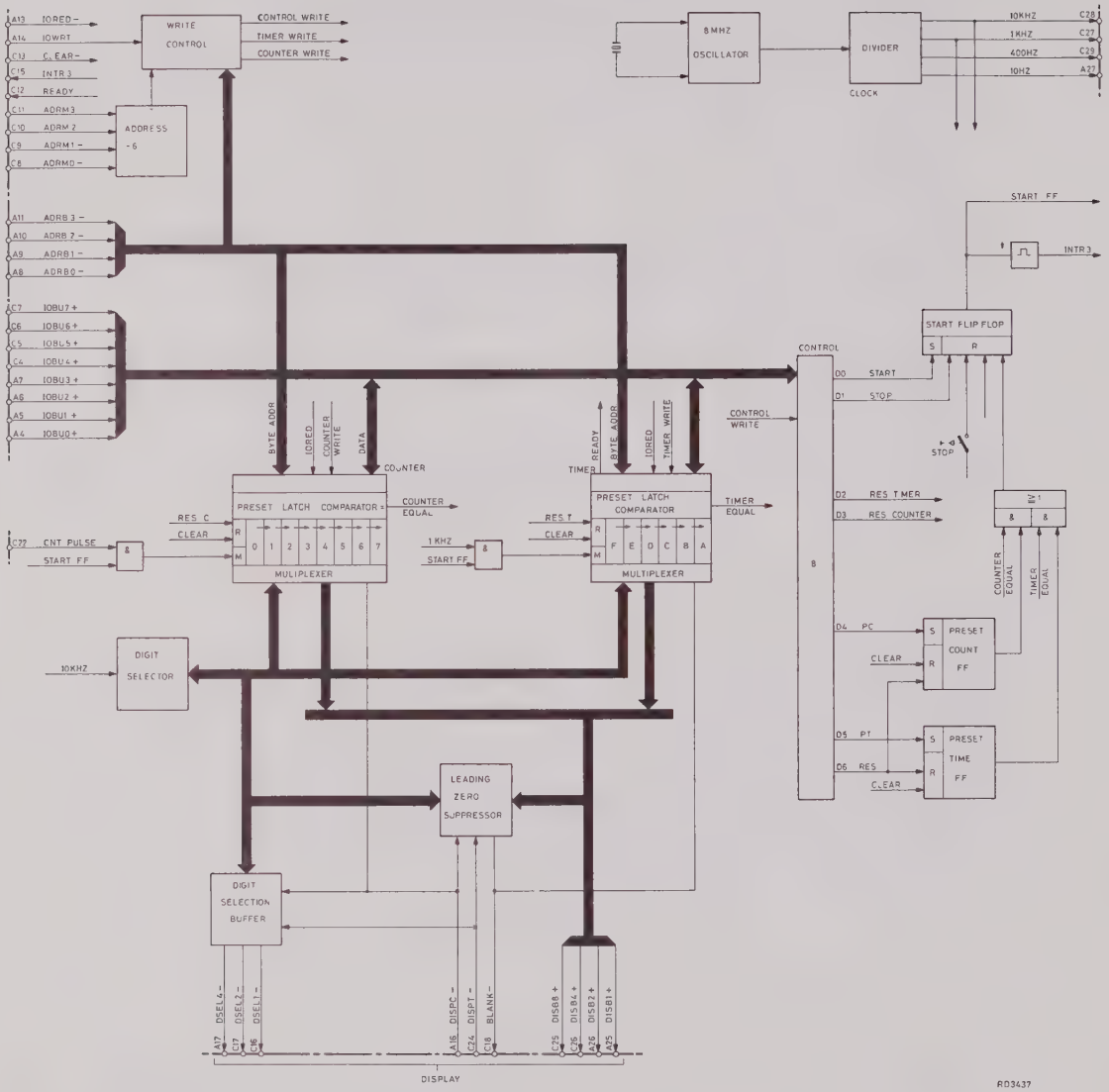
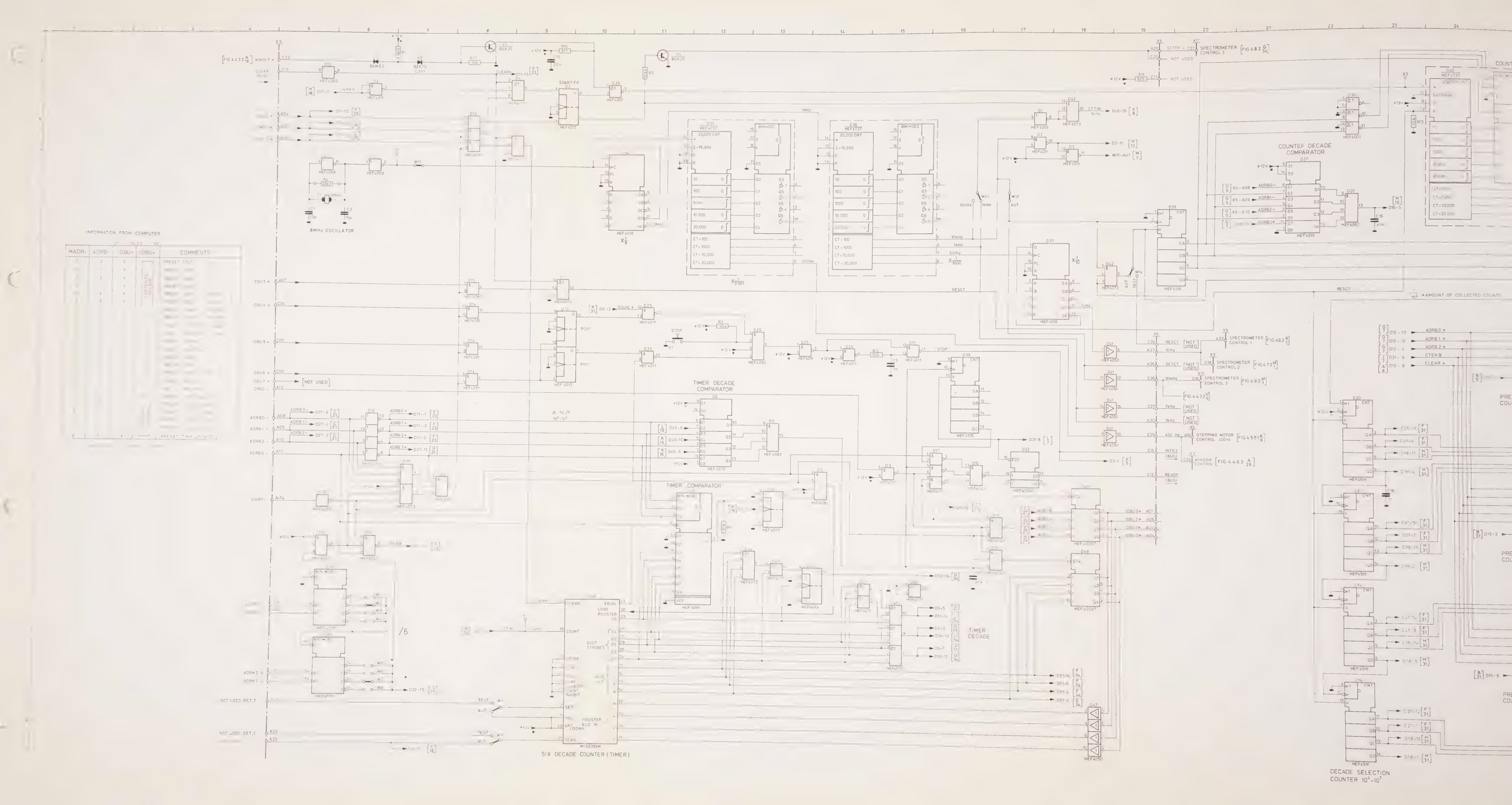


Fig. 4.4.5.2. Counter/Timer (A5) signal flow diagram


INFORMATION FROM COMPUTER
MADR-
ADRB-
10BU+
10BU+
COMMENTS
PRESET COUNT
CONTENTS OF ADR
6MHz OSCILLATOR
START FF
TIMER DECADE COMPARATOR
TIMER "COMPARATOR"
SIX DECADE COUNTER (TIMER)
TIMER DECADE
COUNTER DECADE COMPARATOR
DECADE SELECTION COUNTER 10⁵-10⁰
SPECTROMETER CONTROL 3
SPECTROMETER CONTROL 1
SPECTROMETER CONTROL 2
STEPPING MOTOR CONTROL 400Hz
WINDOW CONTROL
NOT USED
RESET
PRESET TIME DECADE
*AMOUNT OF COLLECTED COUNTS

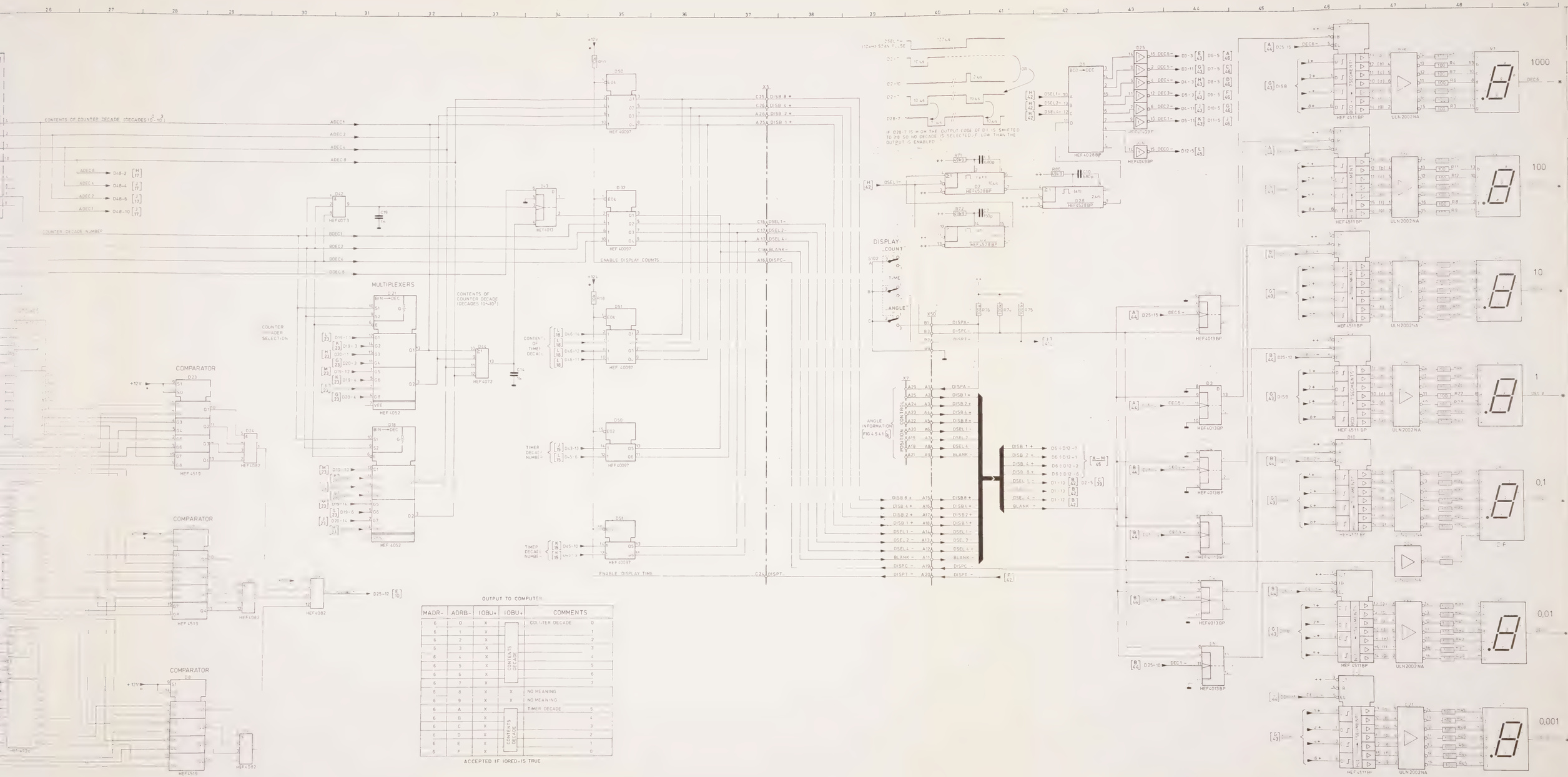


Fig. 4.4.5.3. Counter/Timer (A5) circuit diagram

4.4.5.2. Counter section

The required value of preset count appearing on IOBU lines 0, 1, 2— is read into three eight-bit addressable latches D7, D10, D11, (fig. 4.4.5.3. H/25) when IOWRT— = 0. The decade selection is made by ADRBX—, 4, 5, 6, 7, for decades 10^4— 10^7, with multiplier factors of 1. 2. 3. 4. 5. 6. or 7 times.
Decades 10^0 — 10^3 cannot be preset.
The values preset in the latches D7, D10, and D11, are fed to multiplexers D8, D22, and D23, which are connected to have an exclusive-nor function, and act as comparators.

If the preset-count flip-flop (PCFF) D13—13 (fig. 4.4.5.3. E/9) is set and a start pulse is given (i.e. ADRBx —=/8), the pulses from the amplifier/analyser, WWOUT on X5—C22, (A/4) will be counted by the counters D40 (decades 10^0 — 10^3) and D19 and D20 (decades 10^4 — 10^7).

The outputs of the counter stages D19 and D20 are fed to the comparators D8, D22, and D23, where they are compared with the preset values stored in the latches. When these two values are the same an EQUAL + signal will be produced at D9—13 (K/30). This signal gives, via D25—11, D26—1, D25—3, D25—4, and D17—11 a "stop" pulse INTR3—. This pulse resets the start flip-flop via D3—3 and D4—9 (B/6), and the counter stops.

The multiplexers D18 and D21 (G/31) are scanned by the counter D38, and these feed the contents of the counters D40 and D27 (decades 10^0 — 10^7) to the display outputs DISB 1, 2, 4, 8 + via the tri state buffers D32 and D50. The signal BLANK + is also scanned. This signal is used as one input to the leading-zero suppressor.

If the signal IORED — = 0 (F/4) the contents of the counter D40 (ADECx) are transferred to the input/output bus via D48 (J/18). When all four decades have been read, as determined by the counter D38 (F/16) the signal READY will be given via D17—3, D16—10, and D32.

4.4.5.3. Timer Section

The central part of the timer section is the timer ic, a MOS six-decade counter/display decoder MK 50395 N (MOSTEK) D46.

The decade selection is read into the comparator D6 via the input inverters D12 (G/12) for later comparison with digit strobe outputs of the timer D46.
The preset time value is read into the timer register from the IOBU 0, 1, 2, 3 + [K/19] lines via driver D47 (M/18) when IOWRT— = 0.

Decade selection is made by ADRB— codes /A to /F for the decades 10^0 to 10^5, while the multiplying factor (0—9x) given by IOBU, 1, 2, 3 +. The one-of-eight switch D28 [H/12] functions as a kind of comparator, the output pin 3 being connected to the appropriate input pin in accordance with the BCD code on the ADRBx — lines. When the requested decade has been selected the flip-flop D2 will be set via D28, resulting in a load register command being given to the timer via D5-1 and D46 pin 30. This results in IOBU 0, 1, 2, 3 + being read into the timer register via the drivers D47 (M/18). Via D32 (H/17) READY+ is fed to the bus.

An 8MHz crystal oscillator formed from D1, Z1, etc (C/5) produces, via a series of dividers D34, D35, D36, all the scan frequencies required. In addition this circuit produces a 1kHz frequency which is fed to the counter for use as a time reference.

If the preset-time flip-flop (PTFF) D13 (F/9) is set and a start pulse is given (ADRBx — =/8)
the timing pulses will be counted and compared with the preset value held in the timer register. When the counted time equals the preset time the timer produces an EQUAL signal. This results in the start flip-flop D2 (B/9) being reset by a pulse INTR3, which pulse is also fed to the bus.

When the start flip-flop is reset the counter stops and ADRBx— is compared with the timer decade in D6 (G/12). If this is found to be correct the timer contents are read out to IOBU 0, 1, 2, 3 via D49 (K/18).

The contents of the timer are also fed to the display via D51 (F/35) and DISBx — 1, 2, 4, 8, together with the decade number via DSELx— 1, 2, 4.

		D7 D4	D3 D0	
MADRM–	ADRB–	IOBU+	IOBU+	COMMENTS
6	0	X	MULTIPLICATION FACTOR CONTENTS DECADE	preset count 0
6	1	X		preset count 0
6	2	X		preset count 0
6	3	X		preset count 0
6	4	X		preset count decade 4
6	5	X		preset count decade 5
6	6	X		preset count decade 6
6	7	X		preset count decade 7
6	8	0	1	start counter-timer
6	8	0	2	stop counter-timer
6	8	0	4	reset timer
6	8	0	8	reset counter
6	8	1	0	preset count
6	8	2	0	preset time
6	8	3	0	preset count + time
6	8	4	0	reset presets
6	9	X	X	no meaning
6	A	X	CONTENTS DECADE MULTIPLICATION FACTOR	preset time decade 5
6	B	X		preset time decade 4
6	C	X		preset time decade 3
6	D	X		preset time decade 2
6	E	X		preset time decade 1
6	F	X		preset time decade 0

accepted if IOWRT – is true

multiplication factor x decade eg. 2×10^4 (pres. count) 64X2

ADRM–	ADRB–	IOBU+	IOBU+	COMMENTS	
6	0	X	CONTENTS DECADE MULTIPL.FACTOR	counter decade	0
6	1	X			1
6	2	X			2
6	3	X			3
6	4	X			4
6	5	X			5
6	6	X			6
6	7	X			7
6	8	X	X	no meaning	
6	9	X	X	no meaning	
6	A	X	CONTENTS DECADE MULTIPL.FACTOR	timer decade	5
6	B	X			4
6	C	X			3
6	D	X			2
6	E	X			1
6	F	X			0

accepted if IORED– is true

4.4.6. Window control

4.4.6.1. Introduction

The window control receives information from the I/0 bus and produces two d.c. levels (upper level and lower level) which are used as a comparison for the height of the detector pulses in the amplifier/analyser.
The upper and lower levels are also fed to displays on the spectrometer front panel.

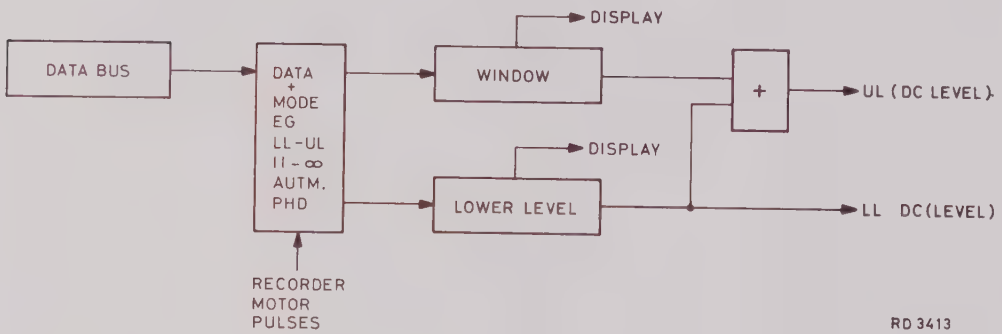


Fig. 4.4.6.1. Window control (A3) block diagram

4.4.6.2. Circuit description

The codes on the I/0 bus and the address bus are given in fig. 4.4.6.3. The code on the I/0 bus is accepted when IOWRT — = 0.

The required mode of operation is decoded by D27 (L/11). Possible modes are:

(a) LL — UL

(b) LL — ∞

(c) Automatic PHD

In the LL — UL mode, ADRBx — = /1 results in the code for the required window setting on IOBUx — being parallel — loaded into the latches (up/down counters) D24 and D25 (B/11). The appropriate FET switches in D16, D17, and D18, will then be closed, applying dc levels to the inputs of the operational amplifiers D6 and D7 (C/15).

The output voltage of the window control circuit is obtained from the reference by means of FET switches, resistors, and an operational amplifier (see fig. 4.4.6.4.).

To ensure that the on-resistance of the FET switches is low in relation to the series resistance where the series resistance is also low, several FET switches are connected in parallel, (e.g. series resistor R71, B/14).

In the modes LL — UL and LL — ∞, ADBRx —= /2 results in the code for the required lower level setting on IOBUx— being parallel — loaded into the latches — up/down counters D21 and D22 (F/15). The lower level is developed in the same way as that for the window.

D20 is preset by byte 3, but in the software for these modes this is always 0000.

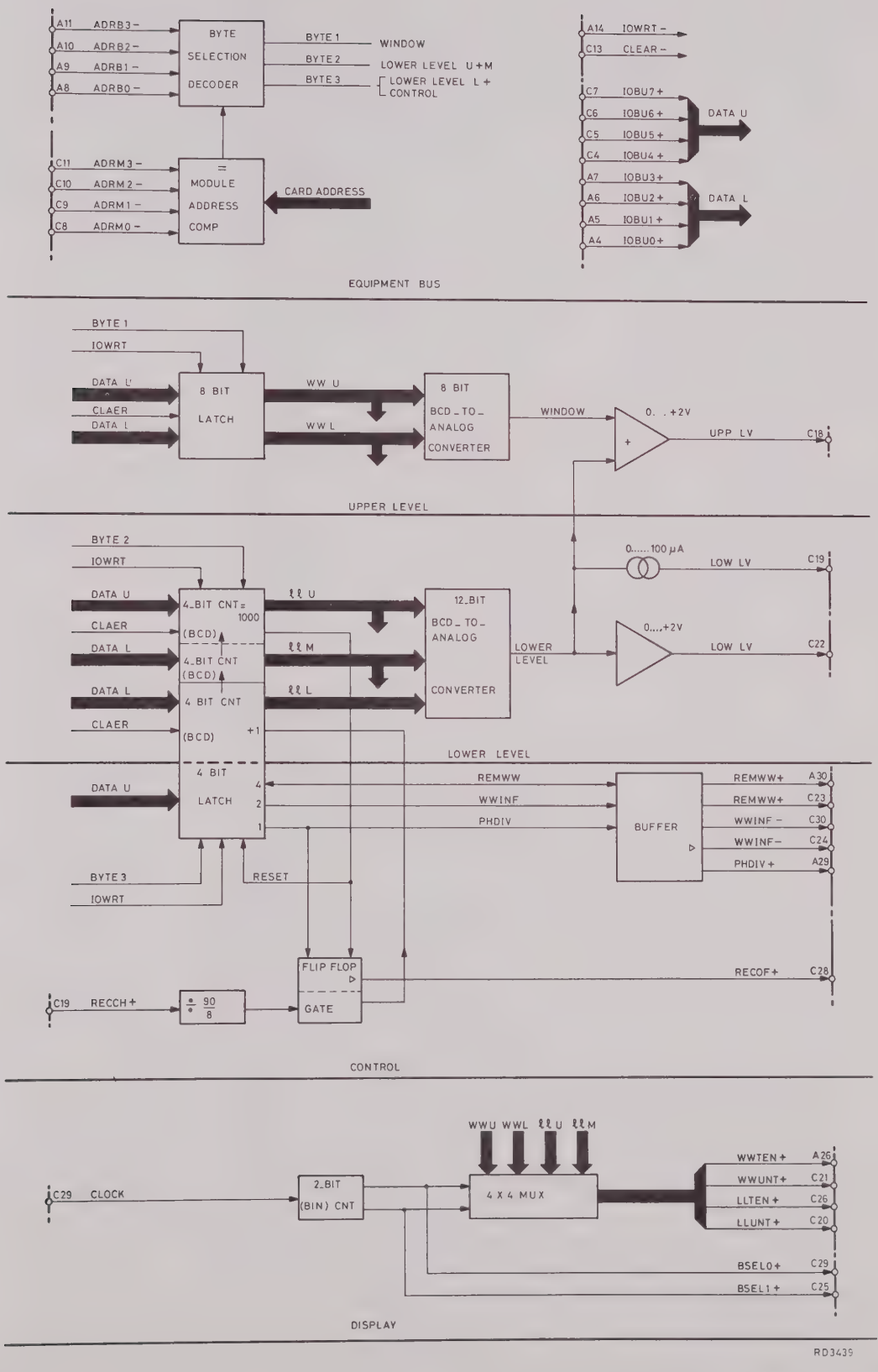


Fig. 4.4.6.2. Window control A3 signal flow diagram

The lower level and window are added at the input to D9 (F/18) to produce the upper level.

This circuit thus produces two dc levels representing upper and lower levels.

In the automatic pulse – height – distribution mode pulses from the recorder stepper motor RECCH + are divided by $\frac{8}{90}$ (see fig. 4.4.6.3. pulse diagram). They are subsequently counted in D20, D21, and D22, and as the output of the counters is incremented, the combination of open FET switches is changed so that the lower level at the output of D5–6 rises in synchronism with the chart recorder paper. When counter D22 is full the resulting carry pulse resets the J-K flip-flop D32 (M/12) and stops the chart recorder motor.

The information on the outputs of the decoders D21, D22, D24 and D25 is also fed to the LED displays. The digital information representing lower level and window is added in D6 (B/24) to produce a display of upper level.

To ensure that a decimal display is always produced from what is essentially a hexadecimal adder, "6" is added to the result when this is more than "10".

e.g. $12_{10} + 6_{10} = 18_{10} = 12_{16}$

and $12_{16} = 2 +$ "carry", so that the display shows "12".

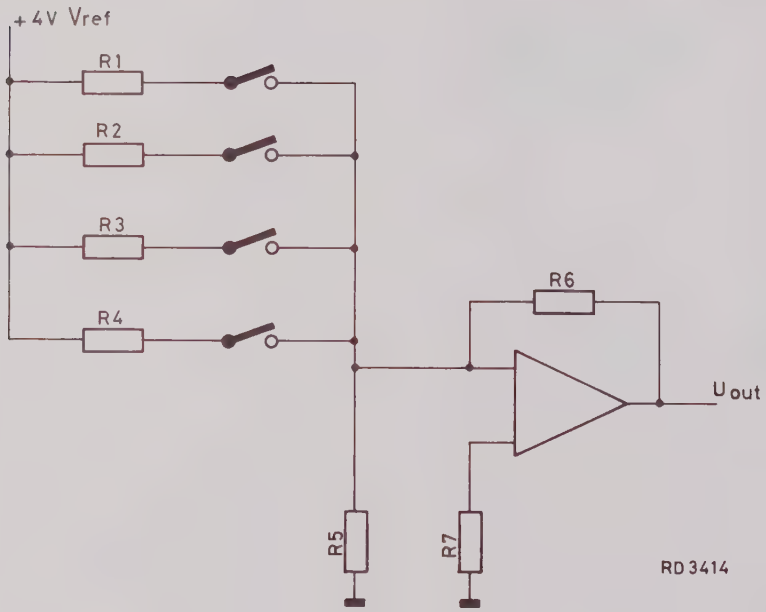


Fig. 4.4.6.4. Window control output voltage circuit

BYTE SELECTION

WINDOW

REFERENCE VOLTAGE

LOWER LEVEL

MODE

BCD WINDOW (TENS)

WINDOW (UNITS)

LOWER LEVEL (TENS)

LOWER LEVEL (UNITS)

DIGITAL TO ANALOG CONVERTER

DIGITAL TO ANALOG CONVERTE

WINDOW SETTING

LOWER LEVEL SETTING

3e STAGE ONLY USED IN ALTOM. PULSH DISTR MODE. IN NORMAL MODE ALL ZERO'S AT D20. PT. 9, 10, 1, 15

RESET AFTER 9TH PULSE

CARRY

START PHDIV+

END PHD V+

CLEAR

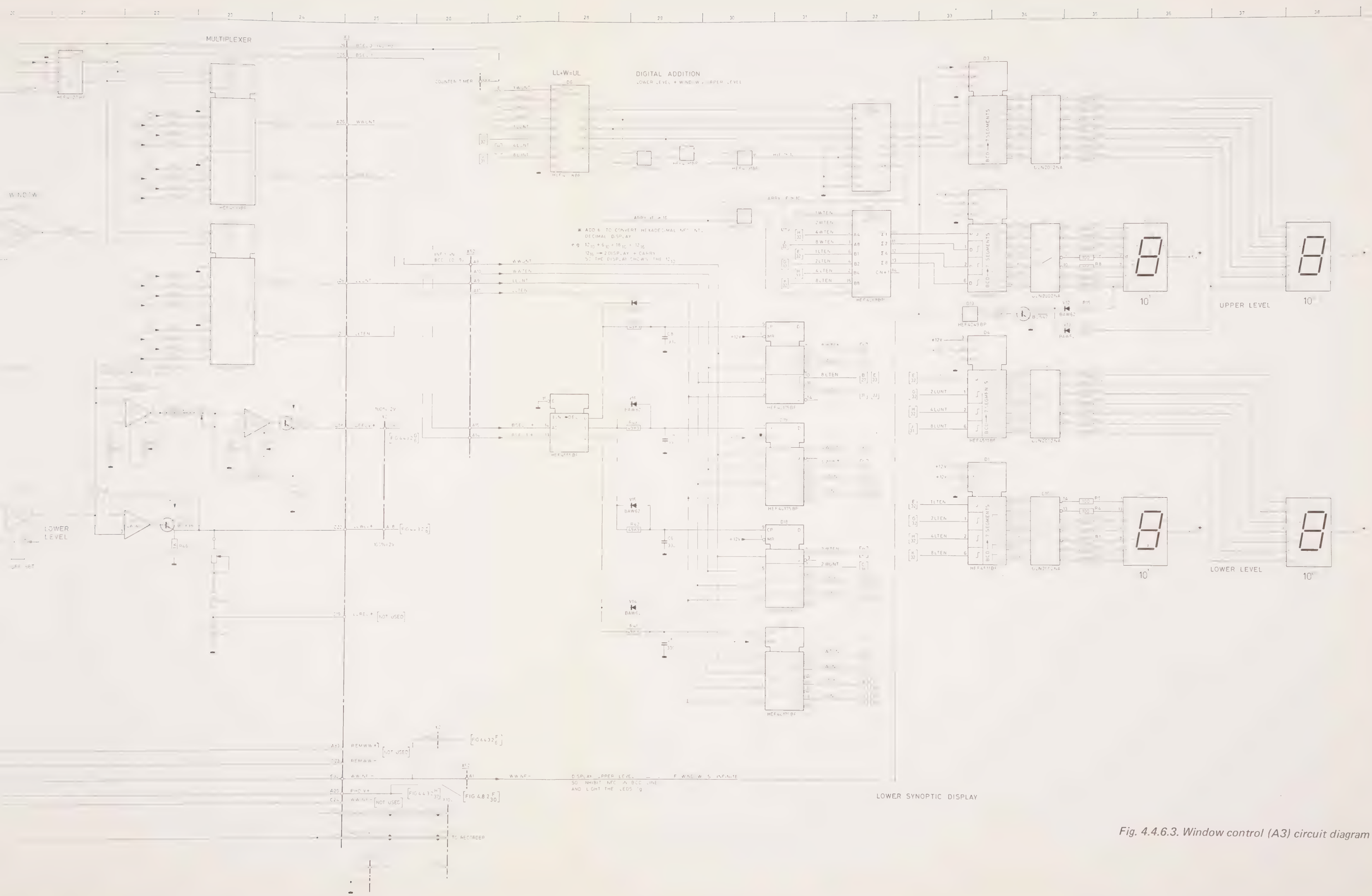

MULTIPLEXER
WINDOW
LOWER LEVEL
LL+W=UL
DIGITAL ADDITION
LOWER LEVEL + WINDOW = UPPER LEVEL
COUNTER TIMER
* ADD 6 TO CONVERT HEXADECIMAL NOT INT. DECIMAL DISPLAY
e.g. 12₁₀ + 6₁₀ = 18₁₆ = 12₁₆
12₁₆ → 2 DISPLAY + CARRY
SO THE DISPLAY SHOWS THE 12₁₀
UPPER LEVEL
LOWER LEVEL
DISPLAY UPPER LEVEL — — — IF WINDOW IS INFINITE
SO INHIBIT INFO IN BCD LINE
AND LIGHT THE LEDS "g"
TO RECORDER
LOWER SYNOPTIC DISPLAY

Fig. 4.4.6.3. Window control (A3) circuit diagram

4.5. MOTOR CONTROL

4.5.1. General

The goniometer of the PW1400 system is driven by a stepping motor, which is controlled by the microprocessor in the system. To make conversation possible between the microprocessor and the stepping motor, three printed circuit boards are used.
These are:

A7 Position control

A6 Stepping motor control

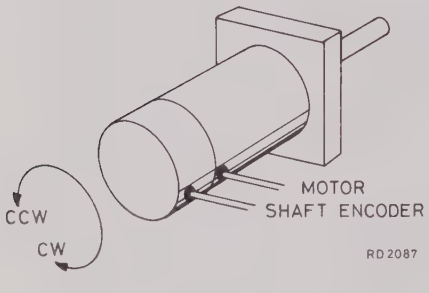
A37 Stepping motor supply/driver

In the first part of this chapter the stepping motor and the printed circuit boards will be described. Following a description of the stepping motor, a survey of the relationship between the printed circuit boards is given in a block diagram, after which the boards are explained in detail.

4.5.2. Stepping motor and shaft encoder

The stepping motor

The stepping motor is constructed in a manner similar to that of a synchronous induction motor and consists of a permanent magnet rotor with 50 teeth, and an 8 salient-pole stator with teeth cut in at a 48 tooth pitch. Each pole has a two-coil bifilar winding, and this permits the use of a single power supply, A simple arrangement will switch one side of the power supply to either end of each winding, see figure 4.5.2.1. The following table shows how the switching sequence will produce clockwise rotation of the rotor (looking at the encoder end). If the sequence is as from bottom to top of the table, the rotation is reversed. Note that the current in windings C and D is the inverse of that in windings A and B.



Step	MCOLA	MCOLB	MCOLC	MCOLD
1	1	1	0	0
2	0	1	1	0
3	0	0	1	1
4	1	0	0	1
1	1	1	0	0

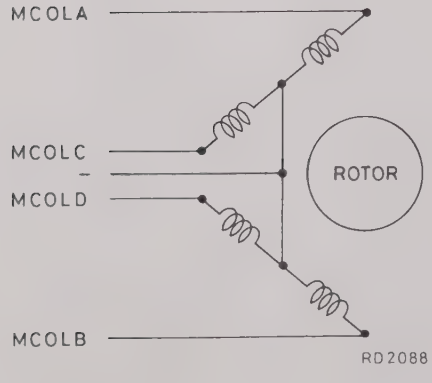


Fig. 4.5.2.1. The stepping motor switching sequence.

The rotor positions for a simplified motor having a four pole stator and a five tooth rotor are shown in figure 4.5.2.2. An arrow is shown at the end of the rotor to indicate its position when the coils are energized as indicated in the above table, and the effect of the magnetic poles produced is also shown.

At each step the magnetic field rotates 90° clockwise and the rotor will advance to a position of maximum attraction 1/4 of a rotor tooth from its previous position. Thus, there are four steps to advance the rotor through 1/5 of a revolution for 5 tooth rotor. The stepping motor used in the PW 1400/00 has 50 rotor teeth, so that there are 200 steps per revolution.

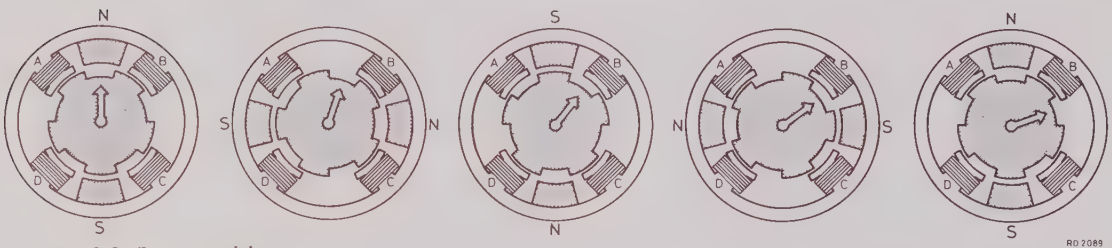


Fig. 4.5.2.2. Rotor positions

Shaft encoder

The shaft encoder is integrally mounted on the stepping motor and consists of three light emitting diodes, a disc mounted on the motor shaft, and three photocells. The disc has 200 slits on 1,8° centres, and two LED/photocells are arranged so that the beam through the slits will give 200 pulses per revolution, but one set of pulses will lag by 0,45°. In addition one slit is on an inner diameter so that one pulse per revolution is obtained from the third LED/photocell combination, see figure 4.5.2.3. The angle between combination A and B is adjusted to be n times 1.8° + 0.45°, where n is a whole number and is approximately 27. The angle between A and C is n x 1.8°, where n is a whole number and is approximately 180° from the A/B combination.

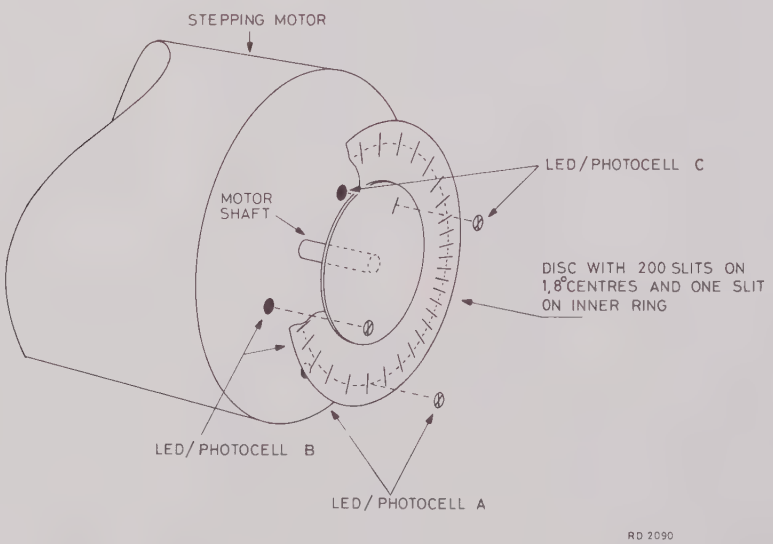


Fig. 4.5.2.3. Arrangement of shaft encoder.

The resultant waveforms from the photocells are shown in figure 4.5.2.4. for clockwise and counter clockwise rotation.

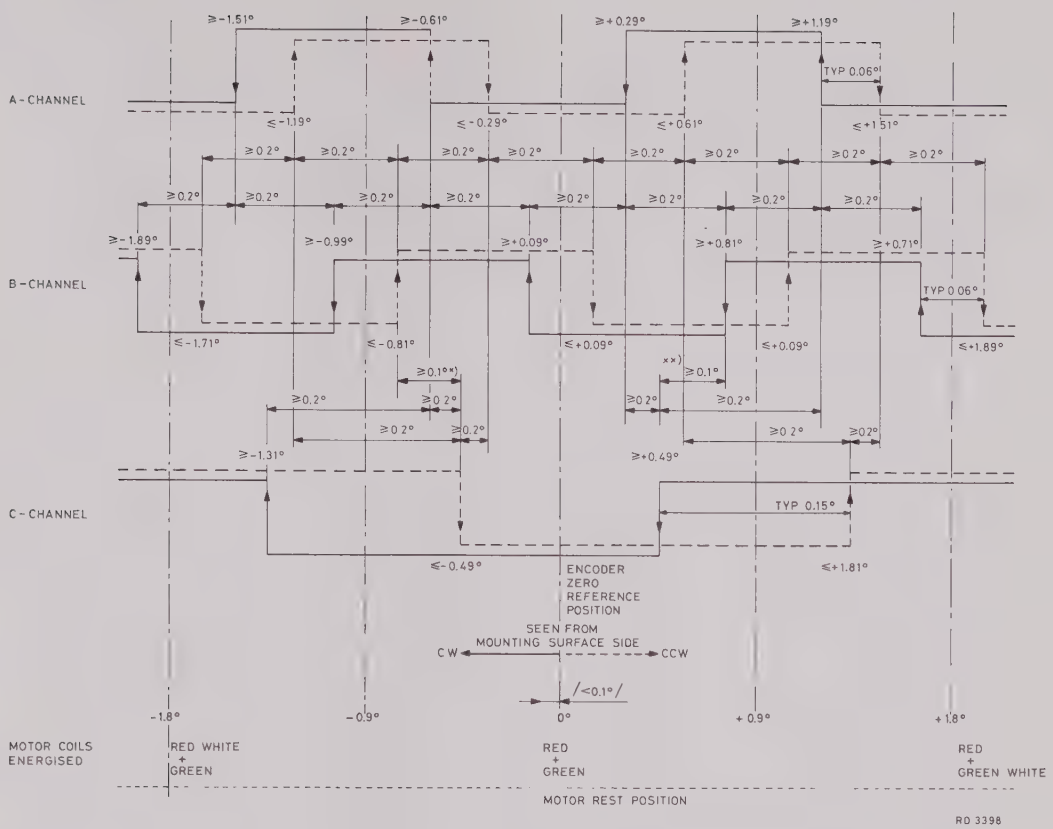


Fig. 4.5.2.4. Shaft encoder waveforms.

The position of the motor is found by counting the member of pulses from the shaft encoder. The direction of rotation is obtained by comparing the signals in the shaft decoder circuit from channel A and B. If the motor is running clockwise (as viewed from the shaft encoder end), there is a trailing edge of the channel B pulse during a channel A pulse. For counter-clockwise rotation the channel B pulse has a leading edge during the channel A pulse.

The circuit configuration of the components mounted on the shaft encoder board in the stepping motor is shown in figure 4.5.2.5.

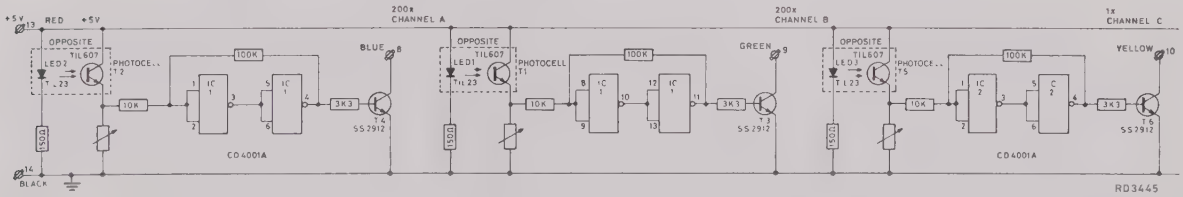


Fig. 4.5.2.5. Shaft encoder circuit diagram

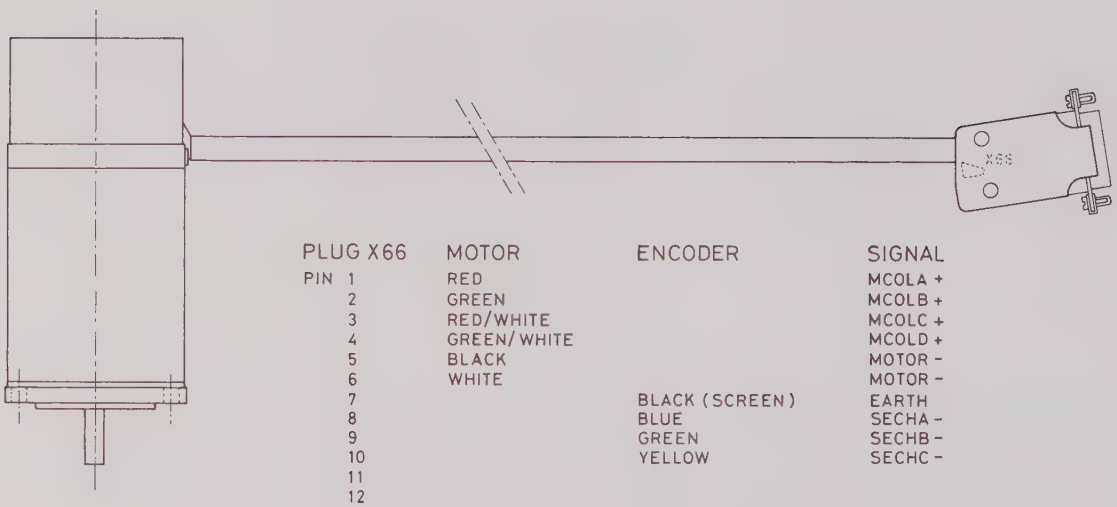


Fig. 4.5.2.6. Stepping motor connections

4.5.3. Block diagram

A wiring diagram of the circuits used in the PW 1400/00 (including the stepping motor control system) is given in figure 4.2.0.2. which shows the main signal routeing, while the signal flow in the control circuits is shown in figure 4.5.3.1.
The data flows to and from the microprocessor via the bus interface p.c.b. to the position control p.c.b. On the position control p.c.b. the required signals to the stepping motor control circuit are generated, and via this p.c.b. the drive signals to the stepping motor drive p.c.b. are made.
This last circuit energises the stepping motor coils to rotate the input shaft of the goniometer.
Positional information from the shaft encoder is fed to the stepping motor control circuit.
The 2θ angle position is displayed by a digital read-out.

4.5.4. Position control

4.5.4.1. General

The position control circuit is shown in figure 4.5.4.1. and is selected via the ADRMxx signals.
The p.c.b. receives data for the different registers on the p.c.b. and transmits signals to the stepping motor control circuit. Data is transfered on command by the signals IOWRT and ADRBxx.
The heart of the p.c.b. is a special MOS six-decade counter/display decoder integrated circuit (MK 50395). Details of this circuit are given in paragraph 4.1.1. This circuit is used as a position generator for the stepping motor and generates the signals required to display the angle setting.
Via the signal IORED and ADRBxx it is possible for the microprocessor to read data from the position control p.c.b. This data can contain angular information or the status of the position control.

4.5.4.2. Position control selection and data transfer

The selection of the position control p.c.b. is done by the signals ADRM 0...3 [B/2] which come from the microprocessor via the bus interface.
The device address of the p.c.b. is /7 which means that the ADRMxx signals must have the following values:

ADRM0 – 0
ADRM1 – 0
$\Longrightarrow$ D9 - 12 = "0"

ADRM2 – 0
ADRM3 – 1
$\Longrightarrow$ D9 - 6 = "0"

The result of this signal condition is that signal ADRRE – becomes "0" if jumpers W1 and W7 are closed. This description is only true when the signal IOWRT – or IORED – is "0", because this signal enables D9-15 and the output D9 - 12 enables D9 - 1.

The signal ADRRE – is connected to the reset input of flipflop D7. When this signal is "1" the flip-flop is in the reset position and the circuit D24 is not enabled so the output D24 - 13 is floating.
As soon as the address of the p.c.b. is recognized, signal READY+ becomes "0" and sets the microprocessor in the idle state.

On the p.c.b. a scan oscillator is mounted, the pulse train of which scans the clock inputs of D7 and the scan counter of D12.
Signal IOWRT – or IORED – enables D6 and,depending on the setting of the ADRBxx, one of the inputs of D6 is connected to the output.
In the following table a survey is given of the signals ADRBxx which switch the input signals S_1...S_6 of D6 to the output 3.

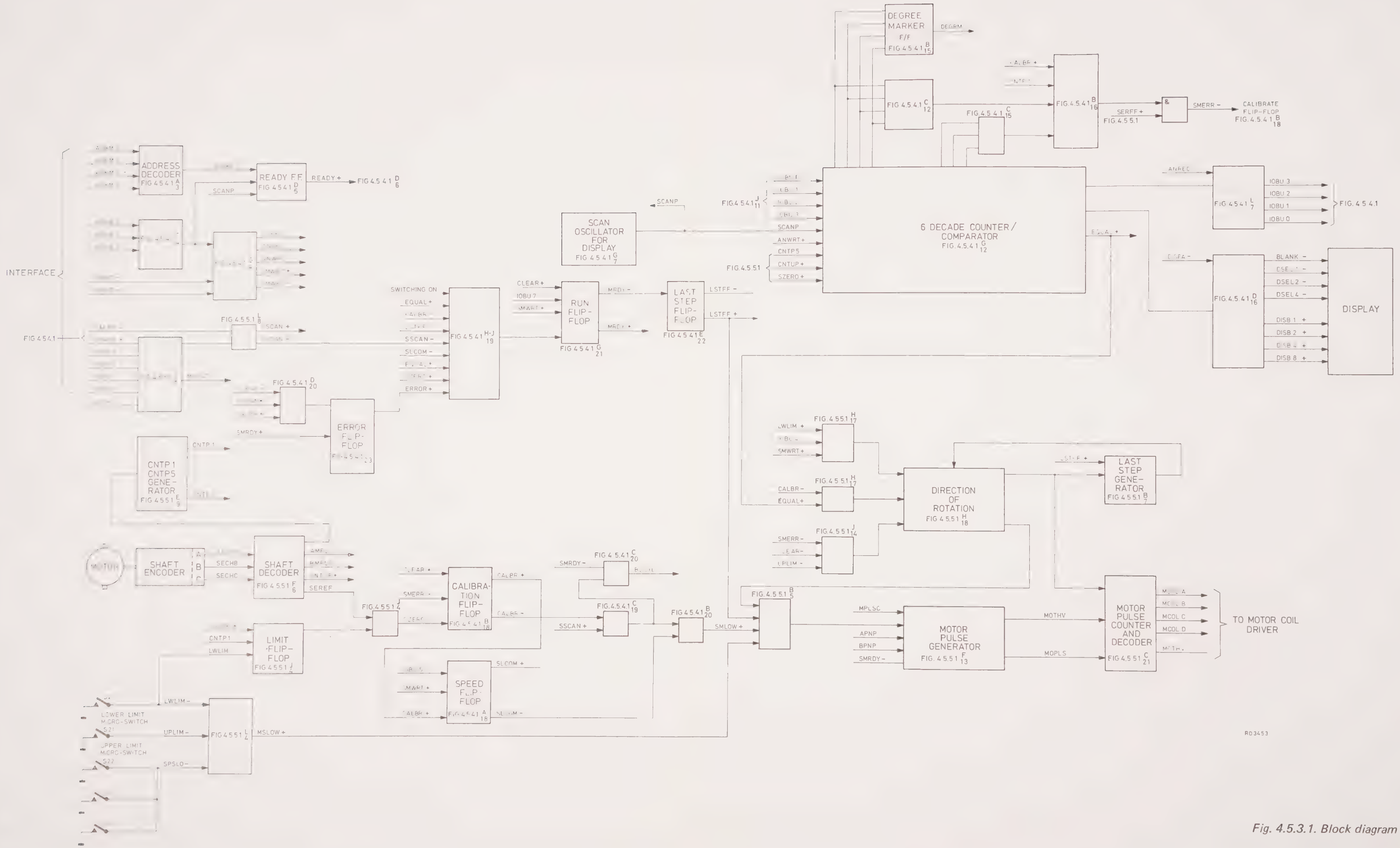


Fig. 4.5.3.1. Block diagram

ADRB–	2	1	0	D6-3
S1	L	L	H	1→3
S2	L	H	L	2→3
S3	L	H	H	3→3
S4	H	L	L	4→3
S5	H	L	H	5→3
S6	H	H	L	6→3

When ADRRE = "0" and output D6 - 3 becomes "1" the following happens, see figure 4.5.4.2.

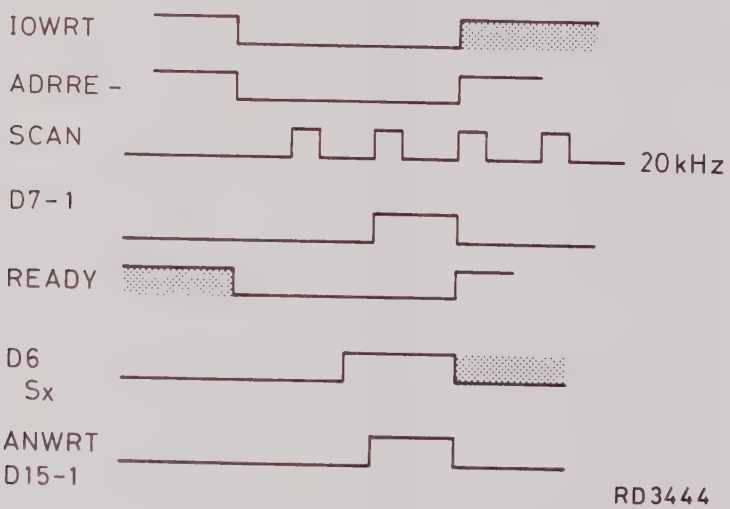
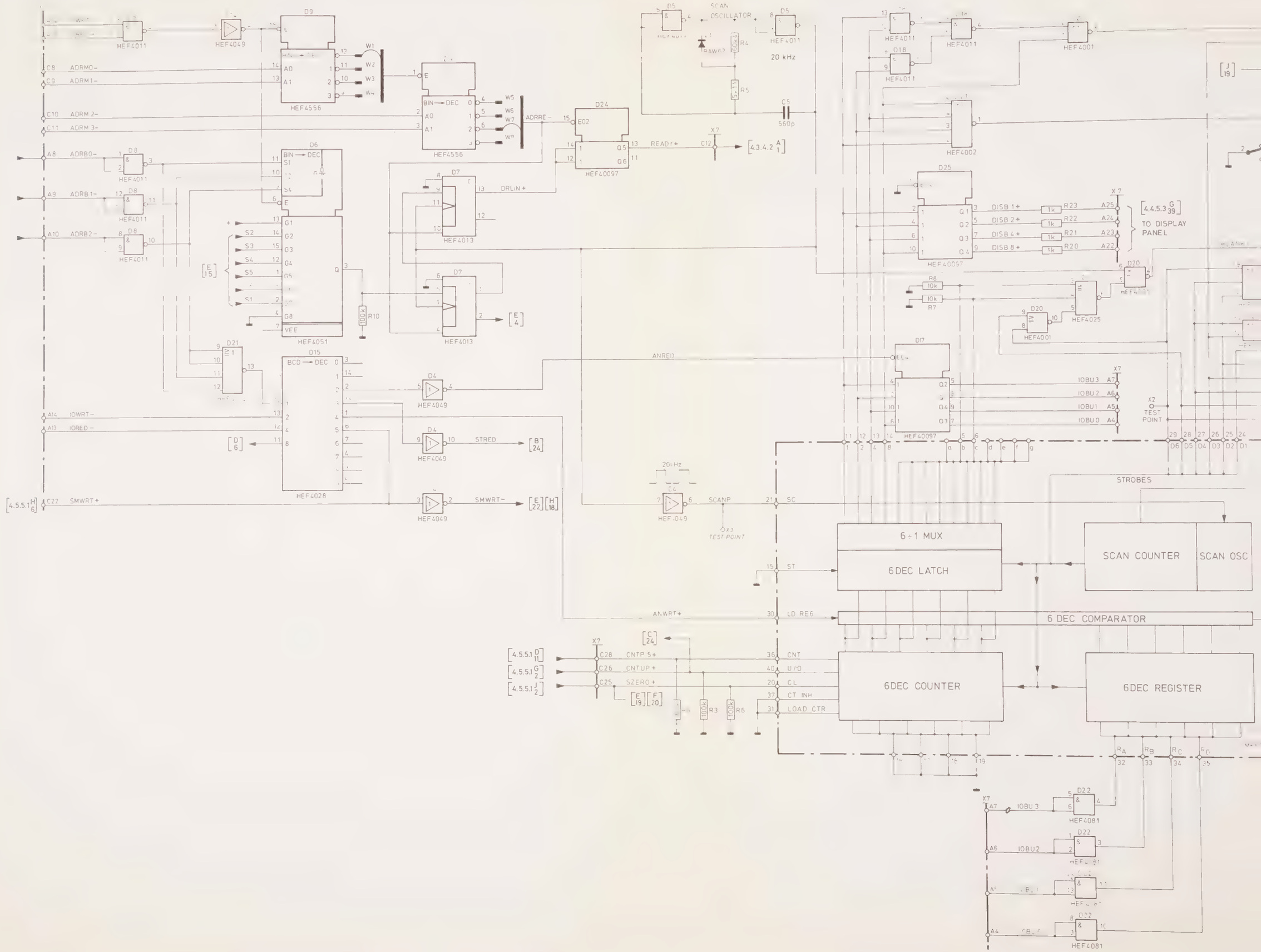


Fig. 4.5.4.2. Timing diagram

The signal from the scan oscillator clocks the signal of D6 - 3 into D7-1. When this becomes "1" output D7-2 becomes "0" and enables D15. The next scan pulse clocks D7-1 = "1" into D7-13 so signal READY+ becomes "1" and the micro processor can perform the next instruction.
During the time between two scan pulses that D15 is enabled one of the outputs of D15 becomes true depending on the input conditions. If one or more signals of ADRBxx is "1", output D21-13 becomes "0". So the following conditions must be fulfilled to have an output high signal at D15 [D/3].

D7–2 [D/6]	IORED	IOWRT	D21–13 [D/4]	
0	0	1	0	ANRED
0	0	1	1	STRED
0	1	0	0	ANWRT
0	1	0	1	SMWRT
1	x	x	x	–


HEF4011
HEF4049
D9
HEF4556
W1
W2
W3
W4
W5
W6
W7
W8
C8 ADRM0-
C9 ADRM1-
C10 ADRM 2-
C11 ADRM 3-
ADRRE-
D24
HEF40097
READY+
X7
C12
[4.3.4.2 A 1]
D5
SCAN OSCILLATOR
BAW62
60k2
R4
5.11
R5
C5
560p
20 kHz
D18
HEF4002
HEF4001
D25
DISB 1+
DISB 2+
DISB 4+
DISB 8+
R23
R22
R21
R20
1k
A25
A24
A23
A22
[4.4.5.3 G 39]
TO DISPLAY PANEL
D20
HEF4025
R8
10k
R7
A8 ADRB0-
A9 ADRB1-
A10 ADRB2-
D8
D6
HEF4051
D7
HEF4013
DRLIN+
R10
100k
[E 15]
[E 4]
D21
D15
HEF4028
D4
HEF4049
ANRED
STRED
[D 6]
[B 24]
A14 IOWRT-
A13 IORED-
D17
IOBU 3 A7
IOBU 2 A6
IOBU 1 A5
IOBU 0 A4
X2
TEST POINT
STROBES
D6 D5 D4 D3 D2 D1
[4.5.5.1 H 6] C22 SMWRT+
SMWRT-
[E 22] [H 18]
20 kHz
C4
SCANP
X3
TEST POINT
SC
6÷1 MUX
6 DEC LATCH
SCAN COUNTER
SCAN OSC
ST
ANWRT+
LD REG
6 DEC COMPARATOR
[C 24]
[4.5.5.1 D 11] C28 CNTP S+
[4.5.5.1 G 2] C26 CNTUP+
[4.5.5.1 J 2] C25 SZERO+
CNT
U/D
CL
CT INH
LOAD CTR
[E 19] [F 20]
R3
R6
100k
6DEC COUNTER
6DEC REGISTER
RA RB RC RD
32 33 34 35
D22
HEF4081
IOBU 3
IOBU 2
IOBU 1
IOBU 0

14 15 16 17 18 19 20 21 22 23 24 25 26 27

DEGREE MARKER FLIP-FLOP

DEGRM+ A27 RECORDER

X5B X5A X7 A29 DISPA- R14 100k +12V

BLANK- DSEL1- DSEL2- DSEL4- R16 R17 R18 R19 1k A21 A20 A19 A18

[4.4.5.3 G 39] TO DISPLAY PANEL

D19 HEF4002

S1 S2 S3 S4 S5 S6 [C 3]

X7 C13 CLEAR- D14 HEF4049 CLEAR+

[G 21][C 24] CALBR+

[4.5.5.1 E 11] C27 CNTP1+ D19 D5

+12V SMERR- D3 HEF4013

CALIBRATION OF MOTOR "1" "0" CALBR+

A.BR- [J 19][F 16]

R13 100k [J 20] [C 24]

[4.5.5.1 H 2] C24 SEREF+

CALIBRATION FLIP-FLOP

+12V R1 301k

R15 100k

C1 22k

C7 IOBU7

[4.5.5.1 J 2] C15 SZERO+

EQUAL+

D2 HEF4013 RUN FLIP-FLOP

SMRDY+ "1" STOP "0" RUN STOP

[E 6] SMWRT- SMRDY- [F 16] SMRDY+ C18 [4.5.5.1 D 12]

C10 100p R11 15k2 D14 HEF4049 INTR2- C14

[F 5]

D1 HEF4023

[G 20][H 18][4.5.5.1 L 9] C29 SSCAN+ SSCAN- LSTFF- SLCOM- D1 HEF4023

R2 100k HEF4049

[D 21] [E 23] SMRDY- HEF4011

[4.5.5.1 G 2] X7 C26 CNTUP+ D13 HEF4013

EQUAL+ LSTFF- LSTFF+ C19 [4.5.5.1 B 5]

LAST STEP FLIP-FLOP

[B 24]

[4.5.5.1 J 2] X7 C25 SZERO+ D5 HEF4011

ERROR+ [B 24]

D14 HEF4049 D10 HEF4011

[F 18][4.5.5.1 L 9] C29 SSCAN+ [C 18] CALBR+

D13 HEF4013 ERROR FLIP-FLOP

SPEED FLIP-FLOP D3 HEF4013

[4.5.5.1 H 6] [E 6] C22 SMWRT+ CALBR+ [C 18] SLCOM+ SLCOM-

D23 HEF4011 SMLOW+ X7 C23 [4.5.5.1 B 5]

[B 14] [D 19]

[D 21] CALBR- D23 HEF4011

[F 18][4.5.5.1 L 9] C29 SSCAN+ D14 HEF4049 D23 HEF4011 STEP2- A28 NOT USED

[E 23] SMRDY- D23 HEF4011 D25 HEF40097 BUSY- A12

STATUS

[E 6] D16 HEF40097 STRED E04

[E 24] SMRDY+ [F 24] ERROR+ [G 16] EQUAL+

[C 18] [G 21] D15 HEF40097

[G 8] CNTUP+ [E 19] SEREF+ Q5 Q6 IOBU1 IOBU0

CALBR+ C17 [4.5.5.1 J 2]

SMERR- C21 [4.5.5.1 J 12]

Fig. 4.5.4.1. Position control circuit diagram

To control the stepping motor it is necessary to write data into the registers on the position control board and to read information from this p.c.b. into the microprocessor.
The write action is done by the signal ANWRT [G/9) if it concerns the 2θ angle and the signal SMWRT [F/6) sets the correct conditions for the stepping motor operation.
The read action is initiated by the signal ANRED [D/6] or STRED [E/6]. With the signal ANRED— the instantaneous value of the 2θ angle is output to the computer, and with STRED the following signals are read into the computer:

SMRDY, ERROR, EQUAL, CALBR, SSCAN, CNTUP and SEREF

These signals give the microprocessor information about the status of the stepping motor.

4.5.5. Switch on

When the system is switched on it takes time for the power supplies to reach their nominal output voltage.
During this time the drive to the stepping motor is blocked by a delay circuit (R1, C1) [D/21] figure 4.5.4.1.
This signal resets the run flip-flop D2 [E/23], so that signal SMRDY+ becomes "1".
The signal SMRDY+ resets the flip-flop D23 [figure 4.5.5.1. C/8], blocks the motor pulses of one-shot D22 [F/13], and the motor is held in the stop position.
The 50ms one-shot D11 does not get AMPLS pulses, which cause output 10 to be "0". The signal MOTHV+ [E/22] becomes low ≈ 5V via gates D4-11 and D32-10.
The signal SMRDY– presets the last step flip-flop D13 (figure 4.5.4.1. G/17) so that LSTFF– becomes "1", and the angle approach counter D2 [figure 4.5.5.1. C/15] is reset.
The flow chart (figure 4.5.5.2.) shows what happens when the power is switched on.

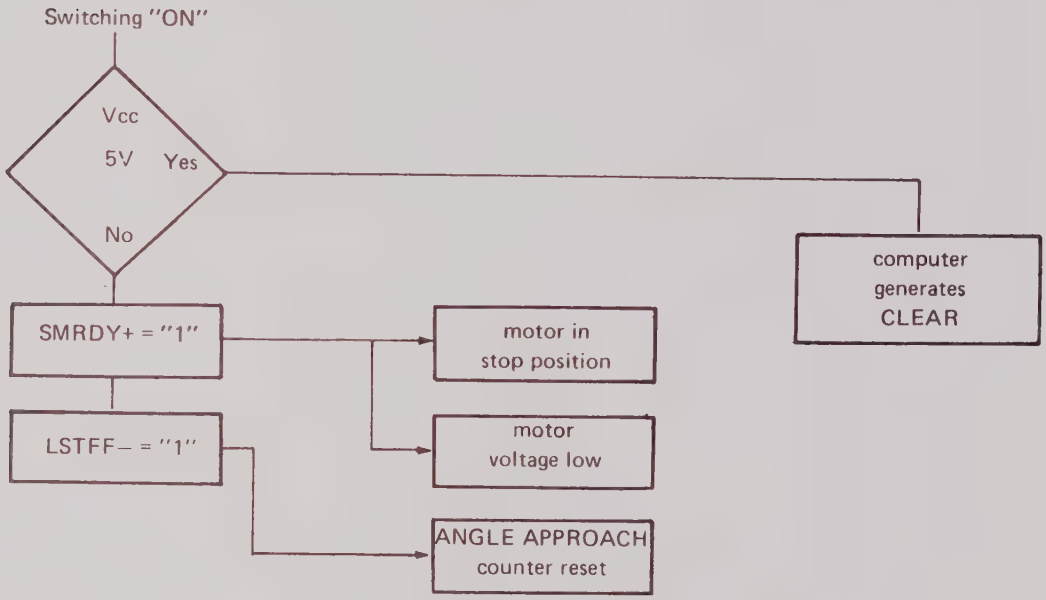


Fig. 4.5.5.2. Flow chart switch-on sequence

4.5.5.1. General reset and calibration

The CLEAR signal from the computer results in the following actions by the position control circuit figure 4.5.4.1. The run flip-flop D2 [E/23] is preset, so that signal SMRDY+ becomes "0" and flip-flop D14—13 [figure 4.5.5.1. H/18] is reset, and signal DIRDN— becomes "0". The signal DIRDN— must be set into flip-flop D14—13 [figure 4.5.5.1.] before the motor can run downwards.
When D14—13 is "1", a "1" appears on the output D25—4 [figure 4.5.5.1. G/18], and the re-triggerable one-shot D11 [figure 4.5.5.1. C/13] is reset. Output D11—11 becomes "1" and enables the astable multivibrator D1 [F/20]. This sets the speed condition via gate D12—13 [B/7] to "0". The input conditions of gate D12—1 [B/17] are "0" for inputs 2 and 3, also for input 4 because signal LSTFF+ is "0". The last step flip-flop is preset via the calibration flip-flop and the signal CLEAR+ [figure 4.5.4.1. G/17].
The output pulses from D1—10 [figure 4.5.5.1. F/20] pass D12 [B/17], and clock the "0" of D14—1 into D14—13 [G/17].
Now the motor pulse counter D29 [C/18] is set in a downward direction, and input 9 of D11 [C/13] becomes "0". The one-shot D11 [C/13] is now triggered by the AMPLS pulse of the shaft encoder. Output 10 of D11 remains high (=1) as long as the trigger pulse arrives within 50 milliseconds.
This high speed resets the astable one-shot D1 [F/20), so that output 10 goes low.
Before the output 10 of D11 goes high, the one-shot D22 [F/13] is triggered by the output pulse of D1—11 via D21—10 [F/12].
The inputs 9, 11 and 12 of D26 [F/14] are "0", so that the pulses from D22 pass D26 to generate the MOPLS motor pulses, and the motor starts running downwards.
At the same time the output signal from the calibration flip-flop D3 [figure 4.5.4.1. D/20] CALBR+ becomes "1" and resets the speed flip-flop D3 [H/19] which results in signal SLCOM— = "1". The run flip-flop D2 [E/23] can now only be reset by the input signals on gate D5—11 [F/21]because signal SLCOM—= 1 makes input 2 of D1 high (= 1).
The error flip-flop D13 [G/24] is set and opens the gate D5—11 [F/21]for the signal SZERO.

The flow chart shown in figure 4.5.5.3. illustrates the above description.

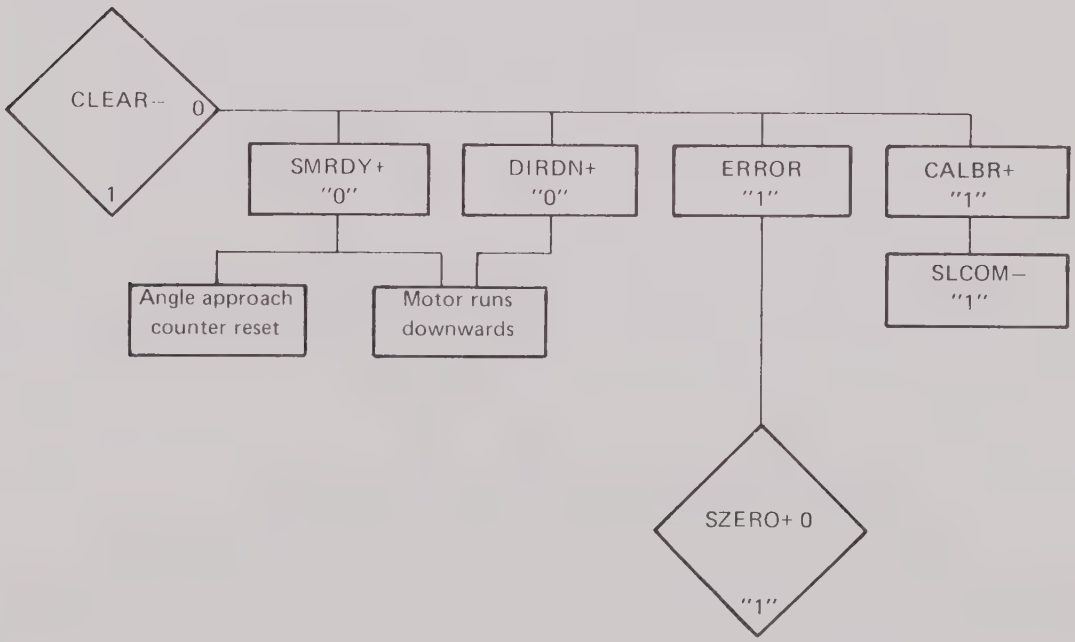


Fig. 4.5.5.3. Flow chart motor reset.

As soon as the microswitch S24 is operated the signal ARDOC becomes "0". The signal MSLOW goes high via D20 [figure 4.5.5.1. 4/K], which results in MOTHV+ = 0 via D12–13, D4–11 and D32–10 and the motor drive voltage is about 5 volts.
Shortly afterwards microswitch S20 is operated, and signal LWLIM– is true.
The direction flip-flop D14 [figure 4.5.5.1. H/17] is set, and signal DIRDN– =1. The input conditions of the exclusive OR D25–4 [G/18] are not equal now, so that the output signal goes high and resets the 50ms one-shot D11. The astable one-shot D1 is enabled, and the output pulse D1–10 goes via D12–1 [B/17] to set signal DIRDN– = 1 into D14–13. The motor pulse counter D29 [C/18] is now set in an upwards direction and the motor rotation is reversed.

When the rotation direction is reversed the goniometer runs upwards, and at the time that the lower limit microswitch returns to its normal position (not operated), a "0" is clocked into the limit flip-flop D6 [figure 4.5.5.1. J/4].

Output 2 of D6 opens the gate D17–4 [J/4] for the signal SEREF +. This signal is derived from the two encoder signals SECHA and SECHC from the stepping motor. These conditions cause signal SZERO+ to become "1" (true) and the motor stops, because SZERO+ and ERROR+ on the inputs of gate D5–11 [figure 4.5.4.1. F/21] are "1", and the run flip-flop D2 [figure 4.5.4.1. E/23] is now reset.
The signal SZERO+ also resets the six-decade counter in the counter/comparator D12 [figure 4.5.4.1. F/11], and the calibration flip-flop D3 [D/20], see figure 4.5.5.1.1. and 4.5.5.1.2.

In addition to the above-mentioned positioning of the spectrometer at the zero position, the angle register is also reset in the counter/comparator D12 [fig. 4.5.4.1.).
In spectrometry use, signal M200D+ is always true (= 1) which means that the detected channel B edges cannot pass D28–10 [E/7]. The shift register D19 [figure 4.5.5.1. D/3] and the exclusive OR D18–3 [D/6] detect the trailing and leading edges of the signals SECHA and SECHB.

Every detected channel A edge resets the binary counter D3 via D28–4 and D5–2, see figure 4.5.5.1.
When the reset comes the output 5 and 7 of D3 become "0", so signal CNTP1 becomes "1".
The 0.5 MHz pulses from the oscillator D16 [F/7] can pass D17–10 [E/11] and the pulses are counted by D3, see figure 4.5.5.1.
The output 9 of D3 gives signal CNTP5 with a frequency of 0.25 MHz. When five pulses are counted outputs 5 and 7 are "1" and the 0.5 MHz pulses are blocked. The signal CNTP5 is used as a clock pulse for the counter comparator D12 [figure 4.5.4.1.], five pulses being necessary because an angle displacement of 0.005° 2θ must be displayed.

After calibration of the system the signals SZERO+ and CALBR+ are "0", when CNTP1 becomes low the limit flip-flop D6 [figure 4.5.5.1. K/4] is reset.
This flip-flop must be reset before the next signal SECHC comes, otherwise, the counter/comparator will be reset again.

4.5.5.2. Angle approach loop

The required 2θ angle position is clocked into the angle register of the counter/comparator D12 [figure 4.5.4.1.] with signal ANWRT. The signal SMWRT clocks the data bits IOBU 0–7 into the direction flip-flops D14 in figure 4.5.5.1. [H/18], speed flip-flop D3 [H/19] and run flip-flop D2 [E/23] in figure 4.5.4.1. These signals determine the mode of operation of the motor as follows.

IOBU

7	6	5	4	3	2	1	0	
start = 1 / stop = 0					0	0	0	scan speed 32° 2θ/min
					0	0	1	16
		low slew speed = 1 / high slew speed = 0			0	1	0	8
					0	1	1	2
			down to lower angle = 1 / up to higher angle = 0		1	0	0	1
					1	0	1	0.5
					1	1	0	0.25
				motor scans = 1 / motor slews = 0	1	1	1	

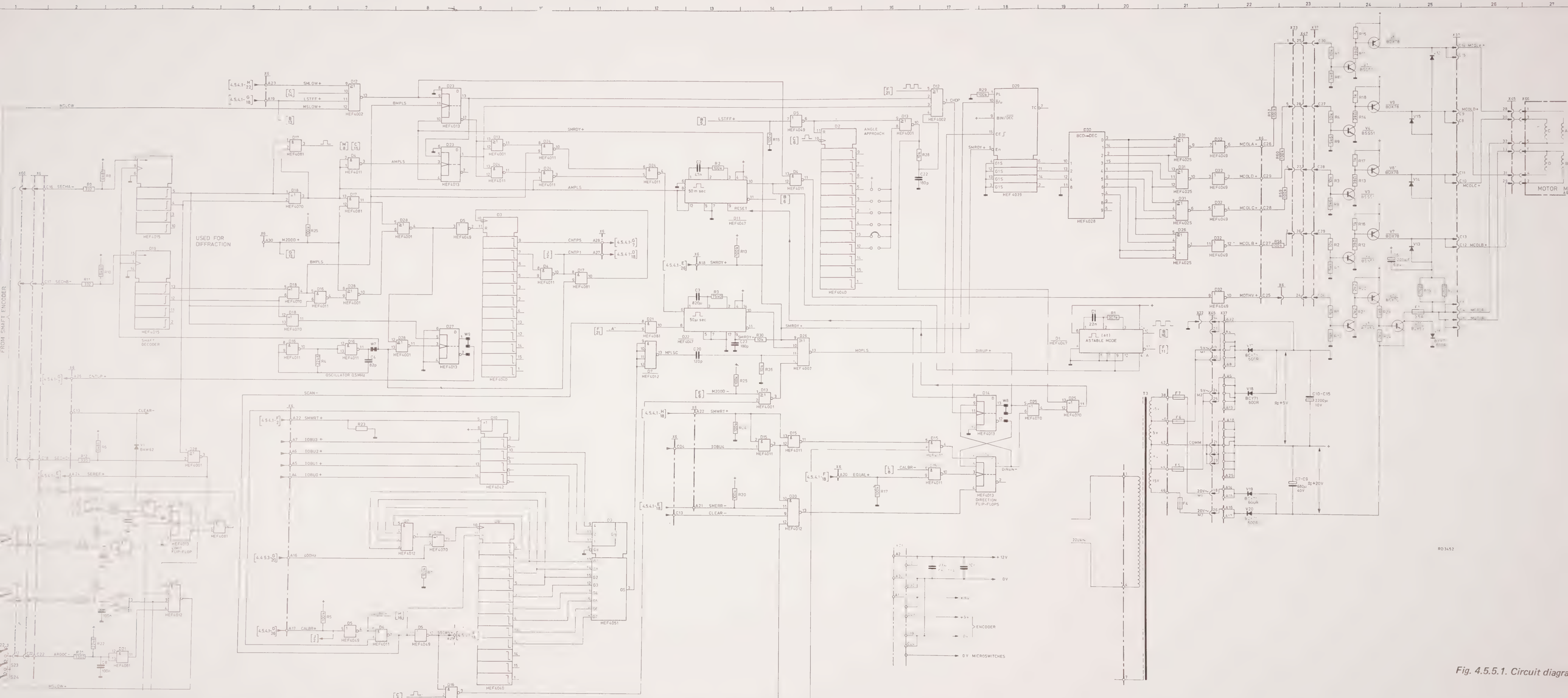


Fig. 4.5.5.1. Circuit diagra

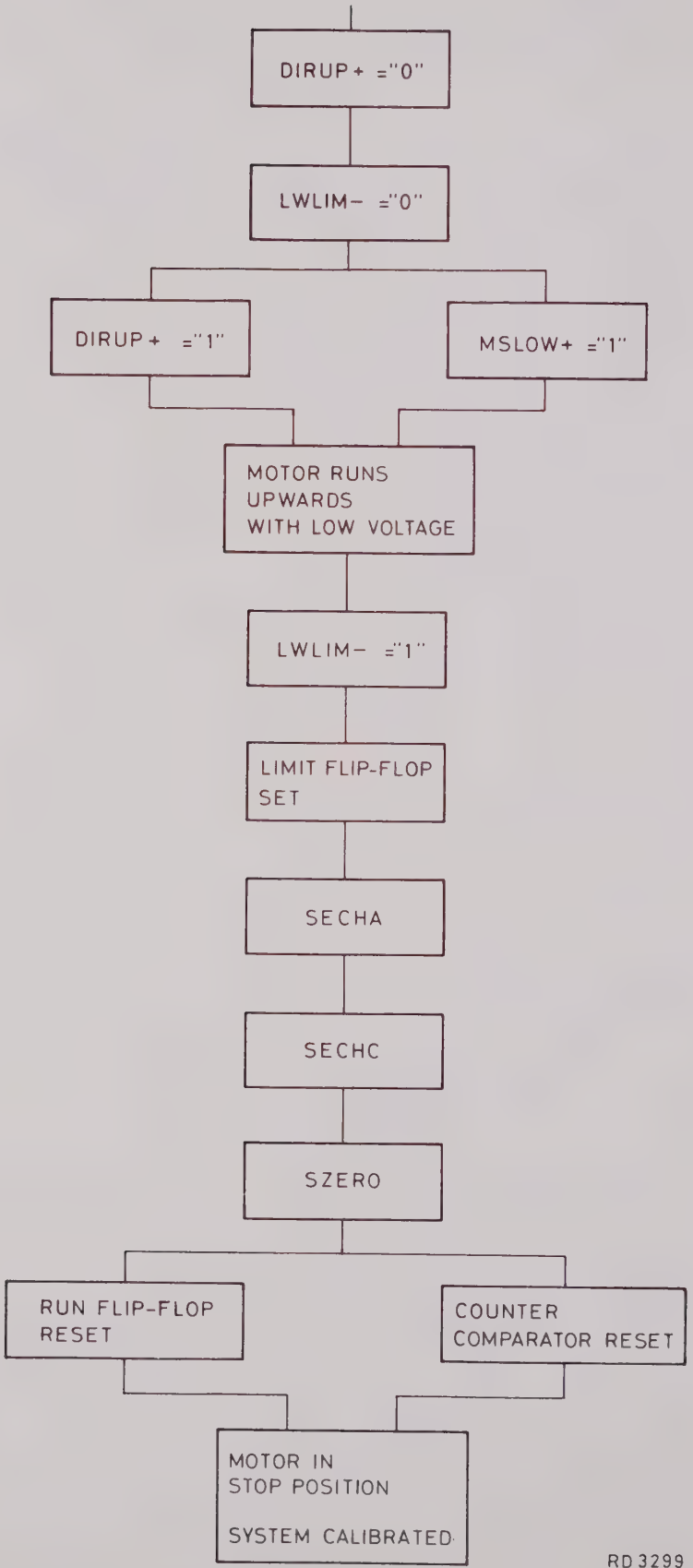
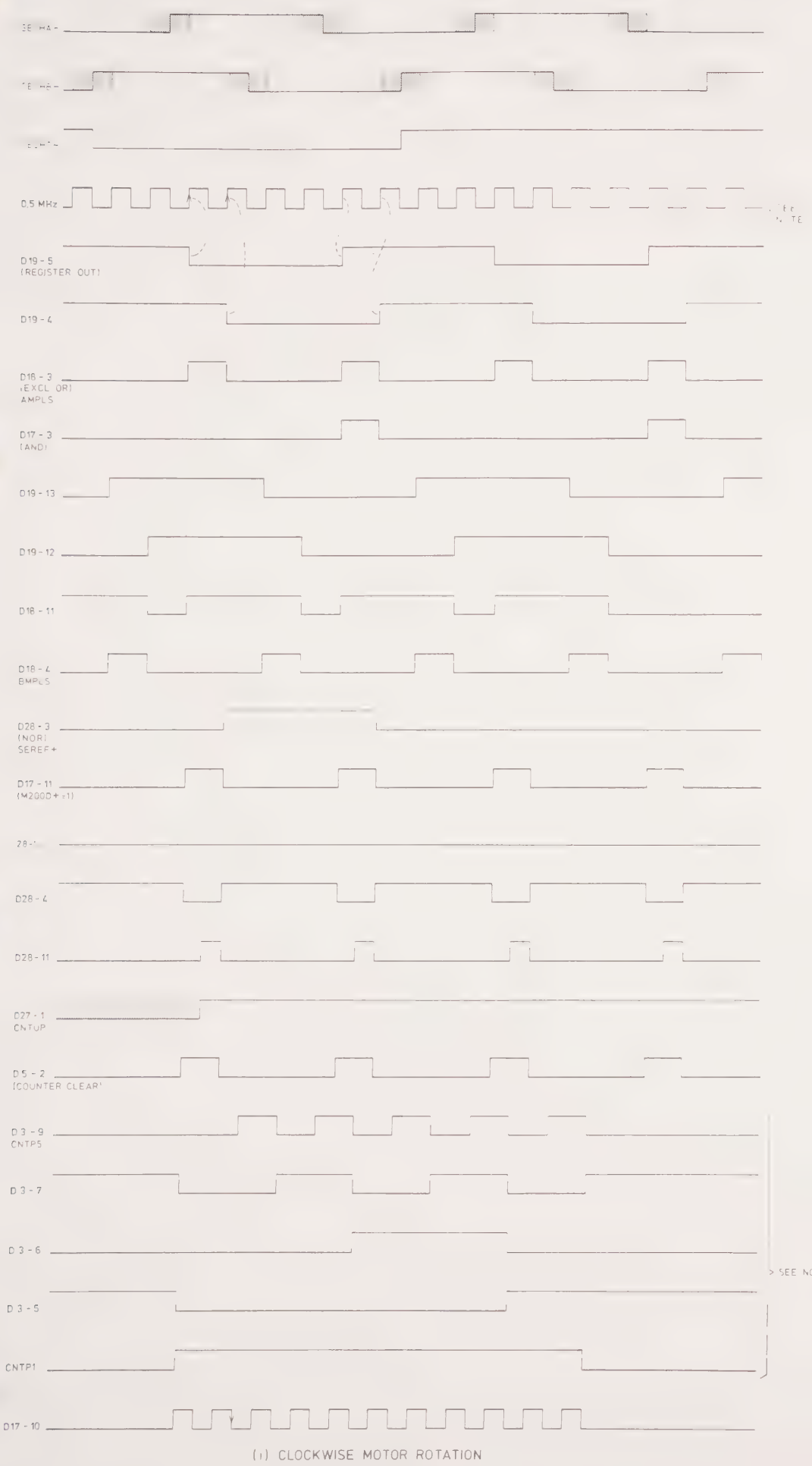
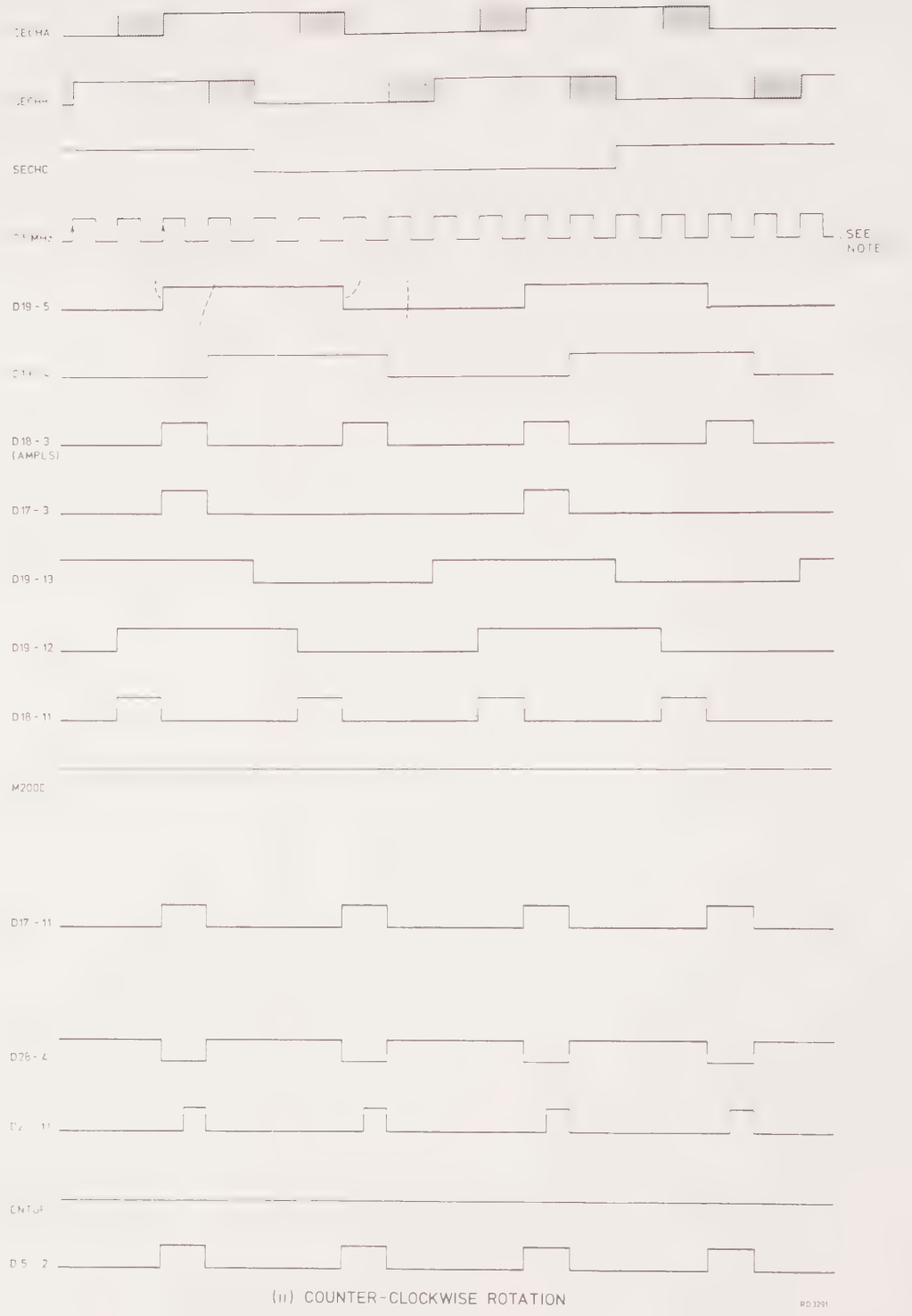


Fig. 4.5.5.1.1. Calibration flow chart.



(i) CLOCKWISE MOTOR ROTATION



(ii) COUNTER-CLOCKWISE ROTATION

Fig. 4.5.5.1.2.
Timing diagram of pulses from encoder.

NOTE: *The rate of 0,5MHz pulses are much faster than shown, so that output from counter D3 (CNTP5) occurs between reset pulses to D3 from D5-2.*

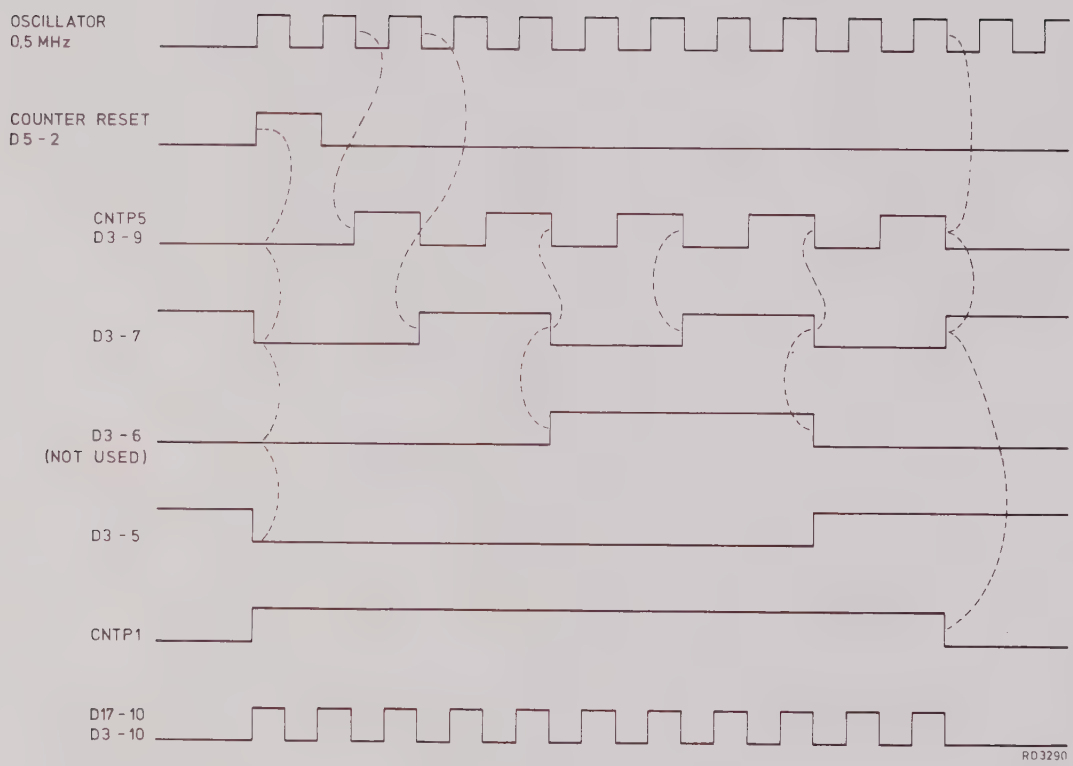


Fig. 4.5.5.1.3. Timing diagram of clock pulses to counter/comparator

The up/down movement is calculated by the computer from the 2θ position of the goniometer of the spectrometer and the required 2θ angle. Suppose movement is required in an upwards direction, then the following will occur when the desired 2θ angle is reached.
When the contents of the angle register in D12 [figure 4.5.4.1.] is equal to the contents of the 6 decade counter, of D12 the signal EQUAL becomes high for a moment. The trailing edge of signal EQUAL+ sets "0" in the direction rotation flip-flop D14 [figure 4.5.5.1. H/18] signal DIRDN– becomes "0" and the output 4 of the exclusive OR D25 [G/18] becomes high. This high signal resets the 50ms one-shot D11 and the speed condition on input 10 of gate D12–13 [B/7] changes via D11–11. Output 13 changes from "1" to "0". The next BMPLS pulse clocks the "0" into flip-flop D23 [B/8]. This "0" is shifted into the other flip-flop of D23 when AMPLS is generated. When these conditions are fulfilled the inputs 2, 3 and 4 of gate D12–1 [B/17] are "0" and the pulse train of D1 can pass D12. This pulse clocks DIRDN–"0" into flip-flop D14–13 [G/18] and reverses the counting direction of D29 [B/18] and the direction of rotation of the motor.

The reversed rotation direction is detected by means of decoder circuits and clocked into flip-flop D27 [F/8], and signal CNTUP+ goes low. At the trailing edge of the next EQUAL+ pulse a "1" is set into the direction of rotation flip-flop D14–1 (figure 4.5.5.1.) and a "0" is set into the last step flip-flop D13 [figure 4.5.4.1. G/17] so LSTFF+ and DIRDN– become "1".
This "1" signal opens the counter D2 [figure 4.5.5.1. C/15], via gate D5–6 [B/14] for a clock pulse derived from the SECHA signal.
The signal LSTFF+ holds the gate output 13 of D12 [B/7] low and the motor runs down with low speed.
When the counter D2 has counted 256 steps the output to D13–10 goes high, and the astable multivibrator pulses of D1 pass D12 [B/17]. The high output on D14–1 shifts to D14–13 and the counting direction of the counter D29 reverses to up.
When the angle position is reached the signal EQUAL+ resets the run flip-flop D2–12 [figure 4.5.4.1. E/23] via D1–6 and D1–9 [figure 4.5.4.1. E/21]. The MOPLS pulses will be blocked due to signal SMRDY+ to D26–13 [figure 4.5.5.1. F/14].
Figure 4.5.5.2. shows the main functions in the angle approach loop.

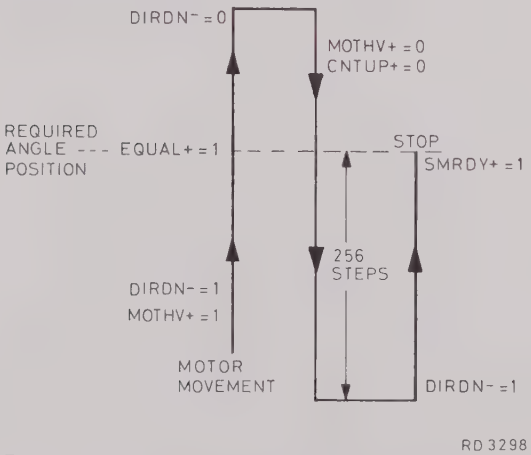


Fig. 4.5.5.2. Angle approach loop

4.5.5.3. Stepping motor fault detection

The signal SEREF (figure 4.5.5.1.), which is derived from the shaft encoder of the stepping motor, is used to control the correct operation of the motor.
The signal SECHC is generated every 200 steps of the stepping motor, and the contents of the last three decades of the register in the counter/comparator D12 [fig. 4.5.4.1.]must be:

0000 0000 0000

If for some reason a fault occurs during the run of the stepping motor, or in the count sequence, the contents of the register will not be zero.
The fault is detected as follows: the signal SCANP scans the counter/comparator D12 and the first scan pulse selects the first decade of the angular setting, and makes S'_1 = "1".
If the decade contains 0001 then input 10 of D19–13 [D/19] becomes "0", so D5–1 = "1". When signal SEREF

goes to "1" then signal SMERR– goes to "0".
This "0" resets the flip-flop D14 [figure 4.5.5.1. H/18], via D20–13 and the motor runs downwards.
When signal SEREF becomes "1" again the calibration flip-flop on the position control board is set. The signal CALBR– blocks the way to reset the run flip-flop D2 (figure 4.5.4.1. E/23]. When the microswitch S22 is activated the stepper motor drive is set to a low voltage, and runs with slow speed. As soon as the lower limit microswitch S20 is activated the rotation direction of the motor is reversed and the lower limit flip-flop is set.

This means that signal SEREF can pass D17–4 [figure 4.5.5.1. J/4] and signal SZERO resets the counter in the counter/comparator D12 [figure 4.5.4.1.].

When the counter is reset the stepping motor starts running to the 2θ angle value, which is still in the angle register of the counter/comparator.

4.5.5.3. Signal DEGRM+

On the position control p.c.b. is a circuit which generates a marker signal as shown in figure 4.5.5.3.

Fig. 4.5.5.3. Degree marker signal

This signal is used as 2θ scale on a chart recorder.
On the output lines of the counter/comparator D12 [E/10] figure 4.5.4.1. the angle value of the 2θ angle is available in B C D form. By means of the signal SCANP one of the decades of the angle value is multiplexed to the output of the counter comparator. The BCD signal is decoded by gates D18 [A/10 and D20 [A/12] which

D12-						
14	13	12	11	D18-11	D18-10	D20-3
0	0	0	0	1	0	1
0	0	0	1	1	0	1
0	0	1	0	1	0	1
0	0	1	1	1	0	1
0	1	0	0	1	0	1
0	1	0	1	0	1	0
0	1	1	0	1	1	0
0	1	1	1	0	1	0
1	0	0	0	1	0	0
1	0	0	1	1	0	0

results in an output signal on D20-3 as shown in the table. When the code which represents the tenth of the 2θ angle is selected, S_3 (E/15) becomes "1".
This "1" clocks the output level of D20-3 (A/12) into the degree marker flip flop D2 [A/14], which results in a DEGRM signal at connector point A27 as represented figure 4.5.5.3.
The flip flop is only operated when the scan is selected by means of IOBU3 = "0" figure 4.5.5.1. D10–2 [H/9]. When the stepping motor is calibrating or slewing the flip-flop D2 (A/14] is in the reset position.

4.5.5.4. Signal BUSYL–

The signal BUSYL– becomes "0" when the stepping motor is slewing or calibrating. When the motor slews signal SMRDY– = "1" and SSCAN = "0" so the inputs of D23 [figure 4.5.4.1. J/20] are both "1" and signal

BUSYL– is enabled via D25 [K/21] ; as soon as SMRDY– becomes "0" again D25 [K/21] is disabled. When, during running of the motor the calibration flip-flop is set, signal CALBR– becomes "0" and independent of signal SSCAN output 4 of D23 becomes "1" so D25 [C/21] is enabled because during calibration SMRDY– "1".

4.5.5.5. Signal INTR2–

The signal INTR2– is a spike derived from signal SMRDY+. The spike is made by means of a delay circuit C10, R11 and gate D14 [figure 4.5.4.1. E/25. At the moment that the motor stops the run flip-flop D2 is set and signal SMRDY+ becomes high, so signal INTR2– goes down for a moment and interrupts the micro-processor via the bus interface.

4.5.5.6. Signals DISPA–/BLANK–

The counter comparator on the position control p.c.b. has the 2θ value of the angle in BCD code on its output. This code is sent to the display via D25 [C/11] . The selection of a digit on the display panel is done via the signals DSEL–x, which signals are enabled when switch S102C labeled "ANGLE" on the PW 1400 is operated, so signal DISPA– becomes low and enables D24 [C/14] . The signals DSEL–x are derived from the output signals S_2 ... S_6 of D12 [E/13] , via gates D11–9, D20–11 and D24.
In the following table a survey of the signals DSEL–x is given depending on the value of Sx of D12.

Sx = "1"	DSEL–x			Digit
	4	2	1	2θ
1	1	1	1	0.005
2	1	1	0	0.01
3	1	0	1	0.1
4	1	0	0	1.
5	0	1	1	10
6	0	1	0	100.

On the display panel digits 5 and 6 can be blanked. For this reason the input 3 of D12 [E/14] is connected to zero. IC D12 [G/12] detects if the numerical value, of the leading digit which must be displayed is zero; if so the lines a, b ... g become low.
In the figure 4.5.5.6. a part of the circuit diagram has been drawn which generates the signal BLANK–.

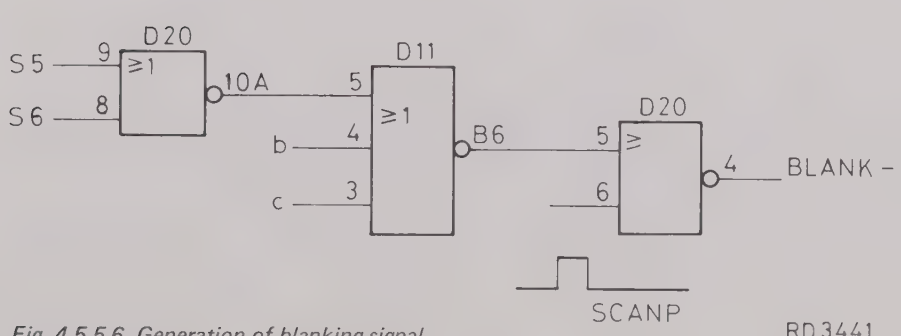


Fig. 4.5.5.6. Generation of blanking signal RD3441

S_5	S_6	A
0	0	1
0	1	0
1	0	0

A	b	c	B	BLANK–
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	0	1
0	0	0	1	0
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1

The digits 5 and 6 are selected by S_5 and S_6. If S_5 or S_6 becomes "1" D11 is enabled via D20.
The output level of D11 depends now on signals b and c of D12 [E/11]. If b and c are "0" point B becomes "1" so signal BLANK = "0".
The signals b and c only become "0" when the digits 5 and 6 both have the numerical value zero, and signal C is "0" if only digit 6 is zero. This situation is detected by D12 [G/12] as mentioned previously.

4.5.5.7. Scan speed circuitry

As previously explained the scan speed can be chosen by means of the IOBU signals 0–3. These signals select,, via D10 fig. 4.5.5.1. [H/9], one of the inputs of D9 [K/11]. The inputs of D9 are connected to the outputs of a 12-stage binary counter D8 [K/9].

This counter gets its clock signal via D18–10, one of the inputs of which is connected to a 400 Hz clock signal while the other input is connected to the output of D7 which gets its input signals from the counter D8.
The output of D7–1 is only "0" when the counter has counted 15 clock pulses, see figure 4.5.5.7.

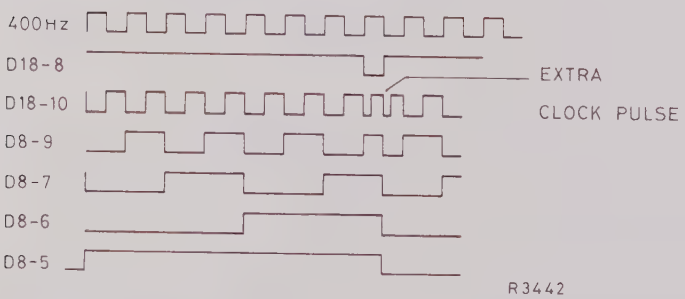


Fig. 4.5.5.7. Scan circuit pulse diagram

After the 15th clock pulse the output of D18–10 goes up again and the trailing edge of the next 400 Hz signal generates a extra pulse for the counter.
Thus the frequency of the clock pulses to the counter is $\frac{16}{15} \times 400$ Hz.

One pulse to the stepping motor results in a 2θ change of 0.005^{o}, resulting in the following scan speeds on the output of D8.

Output D8	Scan speed 2θ/min
7	32
6	16
5	8
3	4
2	2
4	1
13	0.5
12	0.25

$$\frac{\text{Clock frequency x60x0.005}}{\text{counter position}} = \text{speed } 2\theta/\text{min}$$

4.5.6. Stepping motor control

The stepping motor control circuit, shown in figure 4.5.5.1. contains circuits which detect the rotation direction of the stepping motor.

An oscillator and counter (D/3) generate the count pulses (E/10) for the counter/comparator on the position control board. Signals are derived from the shaft encoder and translated to motor drive pulses.
These motor pulses are fed to an up/down counter which is enabled by bit IOBU 4, [H/13] and set to the up or down count mode.

The output signals of the counter are decoded into drive signals which are fed to the motor drive circuit board for motor coils A, B, C and D. (C/21).

4.5.6.1. Motor pulse generator

From the encoder signals SECHA and SECHB the signals AMPLS and BMPLS are derived.
Depending on the output condition of flip-flop D23–13 and D23–1 [figure 4.5.5.1. C/9], a signal due to AMPLS or BMPLS is fed to the trigger input 6 of D22 [F/13].
Figure 4.5.6.1. shows a part of the motor pulse generator circuit.

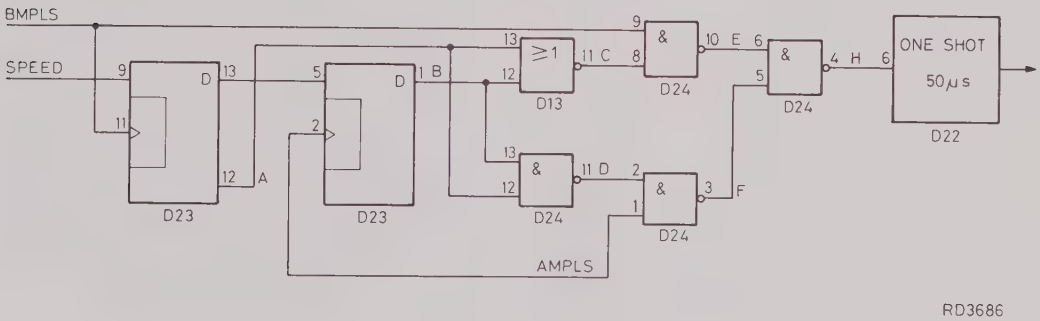


Fig. 4.5.6.1. Motor pulse generator

The speed condition is set by the control circuit; it is "0" (slow) when a limit microswitch is activated or when the 2θ angle approaches its target while in the other situation it is a "1". (MOTHV = 1).
The following table shows the relationship between signal conditions and speed.

SPEED	A	B	C	D	E	F	H
0	1	0	0	1	1	AMPLS	AMPLS
1	0	0	1	1	BMPLS	AMPLS	BMPLS AMPLS
1	0	1	0	1	1	AMPLS	AMPLS
0	1	1	0	0	1	–	–
0	1	0	0	1	1	AMPLS	AMPLS

From the table it can be seen that when the speed changes from "0" to "1" an extra pulse BMPLS is fed to the one-shot and this means that the motor starts running with a higher speed. When the speed changes from "1" to "0" one AMPLS pulse is deleted and the motor starts running with a slower speed.

The output signal of the 50 μs one-shot D22 [F/13] triggers the motor pulse counter D29 [B/18], via D26–13 [F/15].

4.5.6.2. Motor pulse counter and decoder

As mentioned previously, the motor pulse counter (B/19) is triggered by pulses which pass gate D26 (F/14). The count direction is upwards when input D29—10 is "1", and downwards when it is "0". The output signals of the counter are decoded by the BCD—DEC decoder D30 [C/19] and via D31, D32, etc., the motor drive pulses shown in figure 4.5.6.2. are generated.

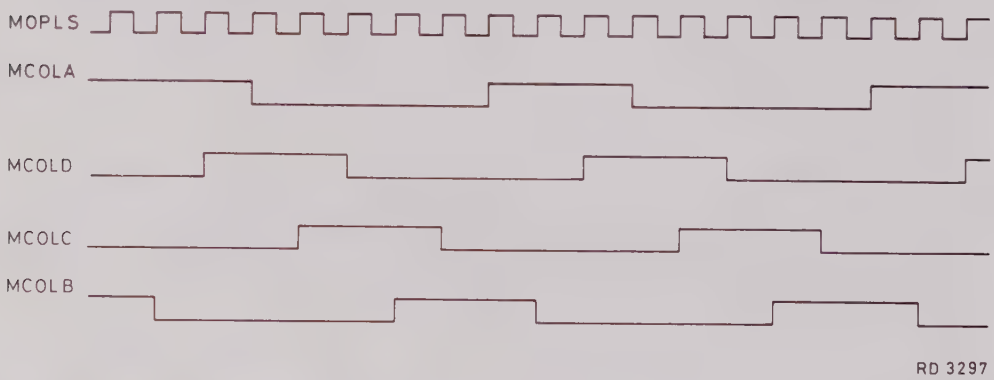


Fig. 4.5.6.2. Motor drive pulses

4.5.6.3. Motor voltage

The motor voltage can have a value of 5 or 20 Volts, and this voltage is set by the signal MOTHV. The signal becomes low when the rotation direction reverses, or a limit microswitch is activated, or 2θ angle approachs its target, or when the SECHA signal is not detected within 50 milliseconds.

Input bit IOBU5 [figure 4.5.4.1. H/19] sets the signal SMLOW if signal SSCAN = "0". From the speed (motor voltage) flip-flop D3 [H/19], the signal SLCOM— becomes "1" or "0" depending on IOBU5. IOBU5 = "1" gives signal SMLOW "1" and via gate D12—13 [figure 4.5.5.1. B/7] MOTHV [F/22] becomes "1", but when IOBU5 = "0" the signal MOTHV becomes "0".

4.5.7. Stepping motor drive

The motor drive circuit, shown in figure 4.5.5.1., energises the coils of the motor from the motor pulse signals MCOLx. These are fed to driver stages consisting of Darlington transistors (V1 to V4) and power transistors (V6 to V9) - figure 4.5.5.1. The voltage across the power transistors and motor coils is controlled by transistor V11 [G/25]. When the MOTHV signal is "0", transistor V5 does not conduct, and due to V10 and V11 the motor will now run from a low voltage.
When signal MOTHV becomes "1" V5, V10 and V11 will conduct and the motor voltage becomes $\approx$ 20V.

The diodes V12—V15 across the motor coils suppress the switching transients from the coils. The diode V16 isolates the 5 Volt power supply from the 20 V supply when the motor is running on high voltage.

Direction of rotation

The mechanical drive from the stepping motor to the $\theta/2\theta$ shaft determines the direction of rotation. A clockwise rotation of the stepping motor (viewed from the encoder end), will drive the goniometer in a upward direction, with increasing 2θ angle.

4.6. X-RAY BEAM PATH CONTROL (SPECTROMETER CONTROL 1)

The control of all the parameters affecting the path of the X-ray beam, except for goniometer angle, is carried ou by the spectrometer control 1 p.c.b. (see fig. 4.6.1. and 4.6.2.).

This p.c.b. is addressed by the microprocessor by means of the "address of module" word /1xxx (ADRM3– ... ADRM0– = 1110, fig. 4.6.2. B/4).
The bytes detected on the p.c.b. are:
/x0 (ADRB3– ... ADRB0– = 1111)
/x1 (ADRB3– ... ADRB0– = 1110)
/x2 (ADRB3– ... ADRB0– = 1101)

The spectrometer control 1 p.c.b. controls the following parameters.

1. Primary collimator
2. Mask
3. Filter
4. Crystal
5. Detector
6. Order of reflection
7. Crystal and order attenuation
8. Display functions
9. Medium (Vactuum-Helium-Air)
10. System status

The bit patterns required to control these parameters are placed on the address bus and the input/output bus by the microprocessor.
These are listed in the following table:

Spectrometer control 1. Bit patterns.

ADRM–	ADRB–	D7 ... D4 IOBU+	D3 ... D0 IOBU+	COMMENTS
INFORMATION FROM MICROPROCESSOR; ACCEPTED IF IOWRT – = 0				
1	0	X	2	SELECT COLLIMATOR FINE
1	0	X	3	SELECT COLLIMATOR COARSE
1	0	X	4	SELECT MASK 2
1	0	X	5	SELECT MASK 1
1	0	X	8	SELECT FILTER IN
1	0	X	9	SELECT FILTER OUT
1	0	1	0	TURN CRYSTAL CHANGER TO ONE POSITION HIGHER
1	0	1	1	TURN CRYSTAL CHANGER TO ONE POSITION LOWER
1	1	X	0	SELECT SCINTILLATION DETECTOR NOT (DETECTOR 2 NOT)
1	1	X	1	SELECT SCINTILLATION DETECTOR YES (DETECTOR 2 YES)
1	1	X	2	SELECT FLOW DETECTOR NOT (DETECTOR 1 NOT)
1	1	X	3	SELECT FLOW DETECTOR YES (DETECTOR 1 YES)
1	1	X	4	SELECT ORDER 2
1	1	X	5	SELECT ORDER 1
1	1	X	6	SELECT ANALYSIS LAMP OFF
1	1	X	7	SELECT ANALYSIS LAMP ON
INFORMATION TO MICROPROCESSOR; ACCEPTED IF IORED– = 0				
1	0	X	1	CRYSTAL IN POSITION 1
1	0	X	2	CRYSTAL IN POSITION 2
1	0	X	3	CRYSTAL IN POSITION 3
1	0	X	4	CRYSTAL IN POSITION 4
1	0	X	5	CRYSTAL IN POSITION 5
1	0	X	6	CRYSTAL IN POSITION 6

1	0	1	X	COLLIMATOR IN POSITION COARSE
1	0	2	X	COLLIMATOR IN POSITION FINE
1	0	4	X	MASK IN POSITION 1
1	0	5	X	MASK IN POSITION 1 + COLLIMATOR COARSE
1	0	6	X	MASK IN POSITION 1 + COLLIMATOR FINE
1	0	8	X	MASK IN POSITION 2
1	0	9	X	MASK IN POSITION 2 + COLLIMATOR COARSE
1	0	A	X	MASK IN POSITION 2 + COLLIMATOR FINE
1	1	0	B	FILTER IN + HELIUM SELECTED
1	1	0	D	FILTER IN + VACUUM SELECTED
1	1	0	E	FILTER IN + AIR SELECTED
1	1	0	F	FILTER IN + NO MEDIUM SELECTED
1	1	1	3	FILTER OUT + HELIUM SELECTED
1	1	1	5	FILTER OUT + VACUUM SELECTED
1	1	1	6	FILTER OUT + AIR SELECTED
1	1	1	7	FILTER OUT + NO MEDIUM SELECTED
1	2	X	1	FILTER BUSY
1	2	X	2	MASK BUSY
1	2	X	3	FILTER + DIAFRAGM BUSY
1	2	X	4	COLLIMATOR BUSY
1	2	X	5	FILTER + COLLIMATOR BUSY
1	2	X	6	MASK + COLLIMATOR BUSY
1	2	X	7	FILTER + DIAFRAGM + COLLIMATOR BUSY
1	2	X	8	CRYSTAL BUSY
1	2	X	9	FILTER + CRYSTAL BUSY
1	2	X	A	MASK + CRYSTAL BUSY
1	2	X	B	FILTER + DIAFRAGM + CRYSTAL BUSY
1	2	X	C	COLLIMATOR + CRYSTAL BUSY
1	2	X	D	FILTER + COLLIMATOR + CRYSTAL BUSY
1	2	X	E	MASK + COLLIMATOR + CRYSTAL BUSY
1	2	X	F	FILTER + DIAFRAGM + COLLIMATOR + CRYSTAL BUSY
1	2	X	X	BUSY LINE TRUE + INTERRUPT 4
1	2	8	X	INTERRUPT 4
1	2	9	X	SYSTEM BUSY + BUSY LINE TRUE

The following functional descriptions are related to fig. 4.6.2.

4.6.1. Primary collimator selection

The primary collimator (coarse or fine) is selected by means of the D-flip-flop D28–1 [D/5]. If IOBU0 + = 1 and the input 3 senses a rising edge, output 1 of D28 will be set and the coarse collimator will be selected (COLVC + = 1).
This will cause Y9 to be energized and Y8 to be de-energized, resulting in the piston in the compressed air actuator moving the coarse collimator into the X-ray beam.

The clock input for the latch is formed by IOWRT– and BYTEO– via the and-gate D4–4 [D/2] and IOBU1 + via D21–4 [D/3]. The rising edge of the write pulse IOWRT– will cause the information on IOBUO to be set into the latch D28–1 [D/4].

The position of the piston is detected by microswitch S26 [A/12] and this results in a "C" appearing on the display V10 [B/15] the information from the microswitch is also put into the buffer D7 [A/25] via the nand schmitt trigger D22 [A/19].
Thus the status of the collimator can be read by the microprocessor when it issues the command BYTEO– = 0 and IORED = 0.

The outputs of the schmitt triggers D22 [A/19] are combined in the nor gate D4–3 [B/21] to produce the signal COLBY+ which is used to detect the time taken by the actuator piston to travel between its end stops. This signal is fed to the buffer D14 [B/24] as a status signal for the microprocessor and is also used as one input to D1 where it is used as one condition for the signal PASET+.

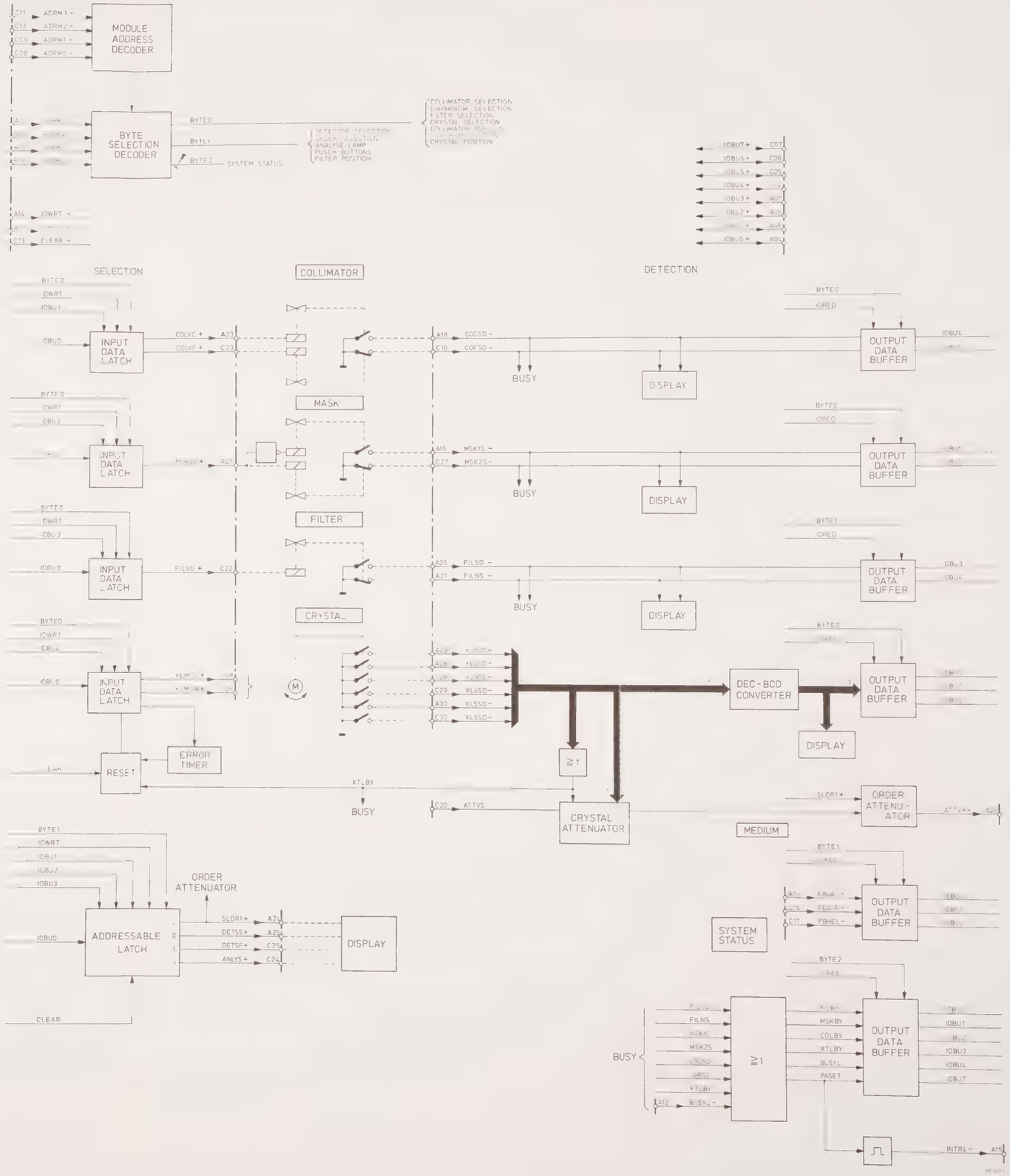


Fig. 4.6.1. Spectrometer Control 1 Block diagram.

4.6.2. Mask selection

The mask is selected in a similar way to that for the collimator, except that the MASK1 position is selected by inverting the MSKV2+ signal via gate D3–12 [F/8] on the coil driver pcb.

4.6.3. Aluminium filter selection

The control circuit for the filter out selection is similar to that for the collimator. However, for the "filter out" selection only one valve Y5 [F/12] is used. When this valve is deenergized a spring returns the filter to the "in" position. This arrangement has the advantage that the filter always returns to the "in" position whenver the spectrometer is switched off, thus ensuring that the filter is always in a position in which it is least likely to be damaged when an X-ray tube is changed.

4.6.4. Crystal selection

The crystal latch D12 [H/4] is reset by the signal CLEAR– via the and-gate D2–3 [H/3]. This results in the latch outputs being XLMCC+= 0 and XLMCW+ = 0. In this situation the crystal drive motor is not energized. This CLEAR– signal also results in the error timer D11 [K/4] being reset.

4.6.4.1. Starting the crystal drive motor

The crystal drive motor can turn in both directions, the direction being determined by the level on the IOBU0 line. This level is read into the latch D12 [J/5] on the rising edge of a pulse on input 9. Since IOBU4+ = 1 and BYTE0– = 0, this pulse arrives when IOWRT–changes level from 0 to 1. The signals XLMCC+ = 1 and XLMCW+ = 0 cause the motor M3 [J/18] to be driven counterclockwise.

4.6.4.2. Detecting the crystal position

The microswitches S5 ... S10 [H/18] detect 1 out of 6 crystal positions. The position of the crystal changer is displayed on V12 via and-gates D8–5, –9 and –10, the BCD-to-7 segment latch/decoder D2, and the darlington driver D5.

The information from the microswitches is also fed via the nand schmitt triggers D32 [E/19] and D34 [D/19], to the gates D29 and D30. The outputs from these gates are used to select one of the FET switches in the ICs D23 [F/20] and D24 [G/21].
The FET switches cause a voltage level to be applied to the operational amplifier D31–8 [F/22].
The applied level is a ratio which depends on the formula:

$$F = \frac{R_t + R_b}{R_b} = \frac{2d\ TLAP}{2d_x}$$

(F = factor related to TLAP)

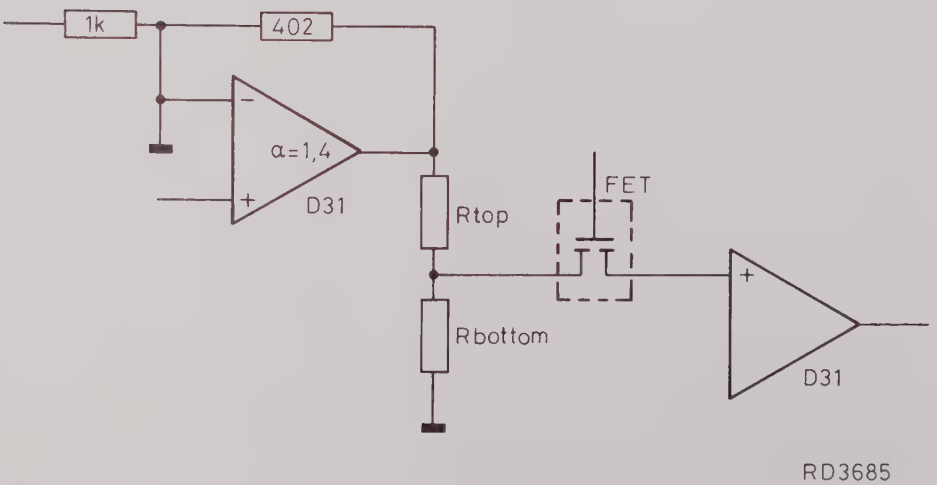


Fig. 4.6.3. Crystal attenuation

SPECTROMETER CONTROL 1

EQUIPMENT BUS

MODULE ADDRESS

BYTE SELECTION

COLLIMATOR

MASK

FILTER

CRYSTAL

ERROR TIMER

POWER SUPPLY

SPECT. CONT. 2

SPINNER

SETTING

DETECTOR 2

DETECTOR 1

ANALYSE

ORDER

COARSE

FINE

COLLIMATOR

MASK

FILTER

CRYSTAL CHANGER

SAMPLE TURRET

SPINNER

OPEN = SWITCHED 12V LINE
CLOSED = SWITCHED 0V LINE

OPEN = 60Hz
CLOSED = 50Hz

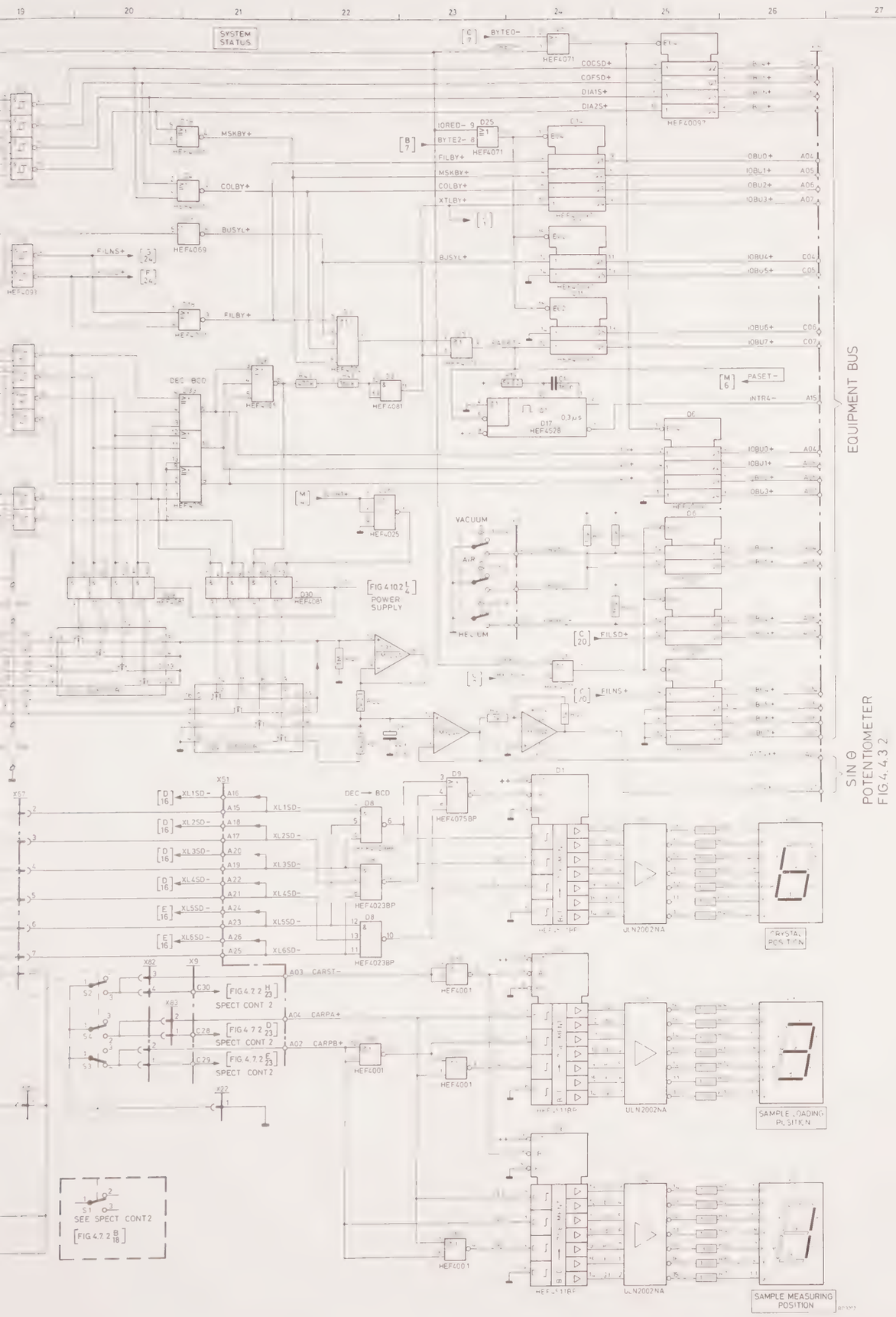


Fig. 4.6.2. Spectrometer Control 1 circuit diagram

In this way the variation in mean pulse height caused by the selection of different crystals is compensated for. This results in the mean pulse height always falling centrally within the "window" range. See also the following table:

Crystal	2 d spacing	F factor related to TLAP	Recommended values F factor	Resistor (Ω) R_{tr}	R_r
TLAP	25.75	1.00	1.00	0	0
ADP	10.648	2.42	2.43	10K	7K0
PE	8.73	2.95	2.84	10K	5K41
InS_b	7.47	3.45	3.43	10K	4K12
Graphite	6.70	3.84	3.84	10K	3K52
Ge111	6.55	3.93	3.94	10K	3K40
LiF200	4.028	6.39	6.35	10K	1K87
LiF220	2.848	9.04	9.06	10K	1K24

The crystal position information on the outputs of the nand Schmitt triggers D32 [E/19] and D34 [D/19] is converted from the six-line decimal format to 3-line BCD format by the or-gates D33 [E/21]. This BCD-information is supplied to the output buffer D6 [E/25], and can thus be read by the microprocessor on command when IORED– = 0 and BYTE0– = 0.

The nor-gate D26 [D/21] combines all the crystal position information lines into a signal which goes high when the crystal drive motor is moving the crystal changer out of one of the six detent positions.
This signal switches the operational amplifier D31–14 [G/23] to ground via FET switch D24–9. This results in a maximum attenuation value being selected whenever the crystal changer is moving (see fig. 4.6.4.).

This same output of gate D26 [D/21] also results, via D2 [D/22] in a signal XTLBY+. This signal is supplied to the output buffer D14 [B/24], where the microprocessor can read the status if IORED– = 0 and BYTE2– = 0. XTLBY+ is also one of the conditions producing the signal PASET– = 1, which causes the LED display V8 SETTING on the spectrometer front panel to be illuminated via the darlington driver D9–12 [M/7].

4.6.4.3. Stopping the crystal drive motor

When one of the six detent positions is reached the output 6 of D26 [D/21] goes low so that after a delay of about 10 ms introduced by R47 and D2–11, XTLBY+ = 0. This delay is necessary to overcome the effects of microswitch contact bounce.

The signal XTLBY+ = 0 results in PASET– = 0 so the one-shot D17–7 [D/24] is triggered, producing an INTR4– pulse for the microprocessor.

The signal XTLBY+ is also used to trigger the one-shot D13 [J/2]. The output pulse of this one-shot directly resets the crystal motor drive latch D12 [H/4] via the exclusive or-gate D18–10 and the and-gate D2–3 [H/3], thus stopping the motor.

The crystal drive motor can also be stopped in an entirely different manner by the error timer D11 [K/4]. When the crystal motor drive latch is set to energize the motor, the error timer will be enabled via D12–3.
The counter will be triggered by the 010 Hz clock pulses. If for any reason none of the crystal position switches causes the latch to be reset D12 within the time preset on the timer (the appropriate jumper 1.6s must be closed) its output will reset the latch via D2–4 [K/3], D18–10 [J/3], and D2–3 [H/4]. The crystal drive motor M2 will thus be stopped, but the signal XTLBY+ = 1 remains in the buffer D14–9 [B/14], providing the microprocessor with the error status of the crystal parameter. Further action remains blocked since PASET– = 0 is not generated.

4.6.5. Detector selection

The detectors are selected via the addressable latch D27 [K/3]. This latch is selected via gate D25–4 by IOWRT– = 0 and BYTE1– = 0.

The 10BU1+ ... 3+ lines, as listed in the following table, are read into the latch when CLEAR– = 1 and IOWRT– changes from 0 to 1.

10BU0+	10BUx+			Output
	1	2	3	
1	0	0	0	SLSCD+ = 1
1	1	0	0	SLFCD+ = 1
1	0	1	0	SLOR1+ = 1
1	1	1	0	ANLYS+ = 1

The signals SLFCD+ and SLSCD+ are displayed on the spectrometer front panel by the LEDs DET1 and DET2 respectively.

In fig. 4.4.3.2. [L/6] the signals SLSCD+ and SLFCD+ switch the scintillation detector and gas flow detector pulses to the discriminator via gates D20-3 and −11 and FET switches D19−9 and −1 respectively.

4.6.6. Order selection

The order selection is stored in the addressable latch D27 [L/3] in a similar way to that for the detector selection. See table in section 4.6.5.

The signal SLOR1+ = 0 results in a selection of 2nd order by bypassing R21 [H/22] to zero volts via gates D26−9 [E/22], D30−11 [F/21] and FET switch D24−1 [G/21]. This results in an attenuation factor of 2 for the level applied to the operational amplifier D31−14 [G/23].

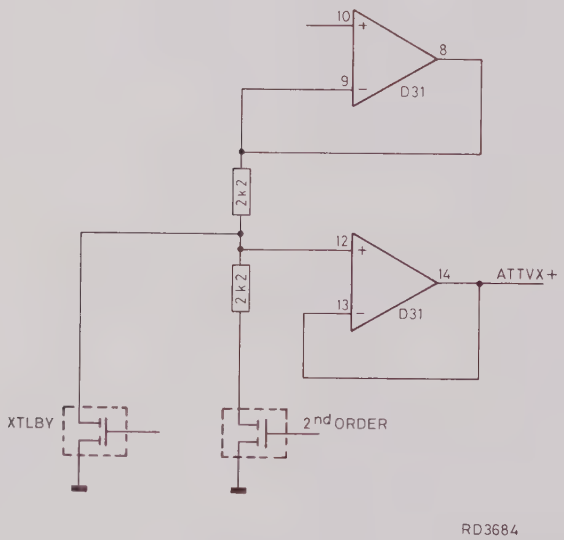


Fig. 4.6.4. Order attenuation

The signal SLOR1+ also results in a "1" or a "2" being displayed on V5 [M/11] via the inverter D13−2 and the darlington drivers D9−14 and −15.

4.6.7. Crystal and order attenuation

Crystal attenuation is dealt with in section 4.6.5. crystal selection, and order attenuation in section 4.6.6. order selection.

4.6.8. Display functions

On the front panel of the spectrometer it is possible to see when a measurement is being carried out as a LED V9 [M/9] ANALYSE will be illuminated. This LED is switched on by the microprocessor via the latch D27−7 [M/2].

All other display functions are described together with the parameters which give rise to them.

4.6.9. Medium selection

The information from the VACUUM, HELIUM, and pushbutton switches on the spectrometer front panel [F/23] is stored in the output buffers D6 and D14. This can be read by the microprocessor when IORED– = 0 and BYTE1– = 0.

4.6.10. System status

All the parameters dealt with in this chapter except for ORDER and MEDIUM, result in a "busy" signal during the time that they are being set. These busy signals are all fed to the output buffer D14 [B/24], where they can be read by the microprocessor when IORED– = 0 and BYTE2– = 0.

All these busy lines, together with the signal BUSYL+ (the collected busy signals from other parts of the equipment) are combined in one general signal of parameter status PASET–. This signal is set in a buffer D15 [D/24] and is displayed on a LED V8 [M/7] SETTING.

PASET– in its turn generates an interrupt INTR4– for the microprocessor via the one-shot D17–7 [E/24]. The microprocessor can thus detect all busy signals. If, for example, the crystal drive motor causes an error, the signal XTLBY+ = 1 will be read via IOBU3+ = 1 and PASET– = 1 will indicate a fault condition via IOBU7+ = 1.

The system status can be read by the microprocessor when it generates the signals IORED– = 0 and BYTE2– = 0.

4.7. SAMPLE TRANSPORT AND ATMOSPHERE CONTROL (Spectrometer Control 2)

The control of the parameters affecting sample loading and transport within the spectrometer, and those determining the measuring atmosphere (vacuum, air, or helium) is carried out by the Spectrometer Control 2 pcb [fig. 4.7.1. and 4.7.2.].

This pcb is addressed by the microprocessor by means of the "address of module" word /2xxx (ADRM3– ... ADRM0– = 1101, fig. 4.7.2. A/4).

The bytes detected on this pcb are:
/x0 (ADRB3– ... ADRB0– = 1111)
/x1 (ADRB3– ... ADRB0– = 1110)
/x2 (ADRB3– ... ADRB0– = 1101)
/x3 (ARBR3– ... ADRB0– = 1100)

The spectrometer control 2 pcb controls the following parameters:
1. Cap and plunger
2. Sample turret
3. Sample chamber conditions (vacuum or air)
4. Helium system
5. Alarm condition
6. System status

The bit patterns required to control these parameters are placed on the address bus and the input/output bus by the microprocessor. These are listed in the following table:

Spectrometer control 2 — Bit patterns

ADRM–	ADRB–	D7 ... D4 IOBU+	D3 ... D0 IOBU+	COMMENTS
INFORMATION FROM MICROPROCESSOR; IOWRT– = 0				
2	0	X	0	CAP UP CYLINDER DEPRESSURIZED
2	0	X	1	CAP UP CYLINDER UNDER PRESSURE
2	0	X	2	CAP DOWN CYLINDER DEPRESSURIZED
2	0	X	3	CAP DOWN CYLINDER UNDER PRESSURE
2	0	X	4	PLUNGER UP CYLINDER DEPRESSURIZED
2	0	X	5	PLUNGER UP CYLINDER UNDER PRESSURE
2	0	X	6	PLUNGER DOWN CYLINDER DEPRESSURIZED
2	0	X	7	PLUNGER DOWN CYLINDER UNDER PRESSURE
2	1	X	0	HELIUM VALVE 2 CLOSED
2	1	X	1	HELIUM VALVE 2 OPEN
2	1	X	2	HELIUM VALVE 3 CLOSED
2	1	X	3	HELIUM VALVE 3 OPEN
2	1	X	4	HELIUM VALVE 4 CLOSED
2	1	X	5	HELIUM VALVE 4 OPEN
2	1	X	6	HELIUM VALVE 5 CLOSED
2	1	X	7	HELIUM VALVE 5 OPEN
2	1	X	8	HELIUM VALVE 1 CLOSED
2	1	X	9	HELIUM VALVE 1 OPEN
2	2	X	0	VACUUM PUMP OFF
2	2	X	1	VACUUM PUMP ON
2	2	X	2	SPINNER OFF
2	2	X	3	SPINNER ON
2	2	X	4	MAIN AIR VALVE CLOSED
2	2	X	5	MAIN AIR VALVE OPEN
2	2	X	6	MAIN VACUUM VALVE CLOSED
2	2	X	7	MAIN VACUUM VALVE OPEN
2	2	X	8	AIRLOCK AIR VALVE CLOSED
2	2	X	9	AIRLOCK AIR VALVE OPEN
2	2	X	A	AIRLOCK VACUUM VALVE CLOSED
2	2	X	B	AIRLOCK VACUUM VALVE OPEN
2	3	1	1	TURN TURRET TO ONE POSITION HIGHER

INFORMATION TO MICROPROCESSOR; ACCEPTED IF IORED– = 0

2	0	X	1	CAP IN HIGH POSITION
2	0	X	2	CAP IN LOW POSITION
2	0	X	4	PLUNGER IN HIGH POSITION
2	0	X	5	CAP + PLUNGER IN HIGH POSITION
2	0	X	6	CAP LOW AND PLUNGER HIGH
2	0	X	8	PLUNGER IN LOW POSITION
2	0	X	9	CAP + PLUNGER IN LOW POSITION
2	0	0	X	GAS + VACUUM FAULTY; TURRET 3 in MEASURING POSITION
2	0	1	X	GAS + VACUUM FAULTY; TURRET 2 IN MEASURING POSITION
2	0	2	X	GAS + VACUUM FAULTY; TURRET 1 IN MEASURING POSITION
2	0	3	X	GAS + VACUUM FAULTY; TURRET 4 IN MEASURING POSITION
2	0	4	X	GAS O.K.; VACUUM FAULTY; TURRET 3 IN MEASURING POSITION
2	0	5	X	GAS O.K.; VACUUM FAULTY; TURRET 2 IN MEASURING POSITION
2	0	6	X	GAS O.K.; VACUUM FAULTY; TURRET 1 IN MEASURING POSITION
2	0	7	X	GAS O.K.; VACUUM FAULTY; TURRET 4 IN MEASURING POSITION
2	0	8	X	GAS FAULTY; VACUUM O.K.; TURRET 3 IN MEASURING POSITION
2	0	9	X	GAS FAULTY; VACUUM O.K.; TURRET 2 IN MEASURING POSITION
2	0	A	X	GAS FAULTY; VACUUM O.K.; TURRET 1 IN MEASURING POSITION
2	0	B	X	GAS FAULTY; VACUUM O.K.; TURRET 4 IN MEASURING POSITION
2	0	C	X	GAS + VACUUM O.K.; TURRET 3 IN MEASURING POSITION
2	0	D	X	GAS + VACUUM O.K.; TURRET 2 IN MEASURING POSITION
2	0	E	X	GAS + VACUUM O.K.; TURRET 1 IN MEASURING POSITION
2	0	F	X	GAS + VACUUM O.K.; TURRET 4 IN MEASURING POSITION

The parameter control functions on the spectrometer control 2 pcb are shown in the block diagram, fig. 4.7.1., while the following description refers to the circuit diagram fig. 4.7.2.

4.7.1. Cap and plunger circuit

When the power is switched on the flip-flop D13 [E/8] and the cap and plunger addressable latch are held in the reset condition. This results in the signal PLUEN+ = 0 which is fed via the motor drive pcb (A36) [Fig. 4.6.2. J/7] to the compressed air valve Y14 [B/19].

From the power supply circuit diagram [Fig. 4.11.1. B/11] it can be seen that 24 Volts (1) and (2) is present when the supply is switched on (PW 1730 mains on).

At the same time the capacitor C21 [D/2] starts charging via R16 (τ= 0.6 s). The valve Y14 can thus only be energized when the voltage on C21 rises to a level which removes the reset condition from the cap and plunger latch D2, and from the flip-flop D13 [E/8]. The valve is energized when the microprocessor produces either PLUVU+ = 1 or PLUVD+ = 1.

Either of these two signals produces a trigger pulse which is applied to input 11 of the flip-flop D13, resulting in the signal PLUEN+ = 1, which in its turn triggers the triac V16 [Fig. 4.6.2. K/4]. Thus Y14 [C/19] is switched to the inlet to valve Y1.

Note that the cap and plunger latch is not affected by a reset of the PW 1400/00 – if a reset is generated the control situation of the compressed air valves remains unchanged.

The cap and plunger addressable latch D2 [C/4] is enabled when IOWRT– = 0, BYTE0– = 0 and IOBU4+ = 0.

The relevant flip-flops are selected as follows:

		IOBU1+	IOBU2+	IOBU3+
(A0)	CAPVU+	0	0	0
(A1)	CAPVD+	1	0	0
(A2)	PLUVU+	0	1	0
(A3)	PLUVD+	1	1	0

The state of the addressed flip-flop depends on the signal IOBU0+.

For example, the signal CAPVU+ = 1 when the microprocessor issues the signals shown in fig. 4.7.3.

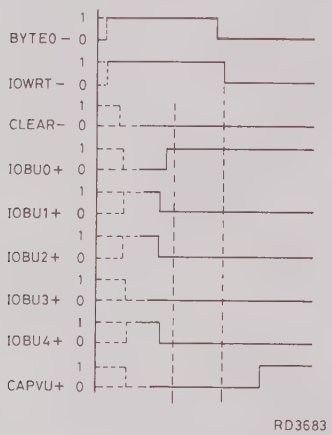


Fig. 4.7.3. Production of signal CAPVU+

The four signals CAPVU+, CAPVD+, PLUVU+, and PLUVD+ are all fed to an interlock circuit formed by the gates D3 [D/6] and D5 [D/7]. This circuit provides the necessary protection for the plunger and cap mechanisms and ensures the proper operating sequence of these mechanisms when the spectrometer is under vacuum.

The two final states of the plunger and cap mechanisms are shown in fig. 4.7.4. The timing diagram shows the operational sequence (the length of the lines is irrelevant). The operation of the system to control the medium (vacuum, helium, air) is not shown in the figure.

In order to generate the signal PLUVD+ at the output 9 of D5, the state of the latch D2 [D/4] must be:

CAPVU+ = 0
CAPVD+ = 1
PLUVD+ = 1
PLUVU+ = X

Thus the coil drive buffer D1–13 [A/14] can only have a high output if the energization of the compressed air valves is such that the cap is down and the valve for "cap up" is not energized. Also, before the coil of the valve Y1 can be energized, the microswitch S1 (sample turret in rest) must be actuated (see also fig. 8.2.8.).

Several microswitches are actuated by movements of the plunger shaft. Two of these, S14 and S15 detect, respectively, the high and low positions of the plunger [A/20]. The state of these switches is read into the output buffers D25 [C/30] via the nand Schmitt triggers D27 [C/25]. The status of these switches can thus be read by the microprocessor when it produces the commands BYTE0– = 0 and IORED– = 0.

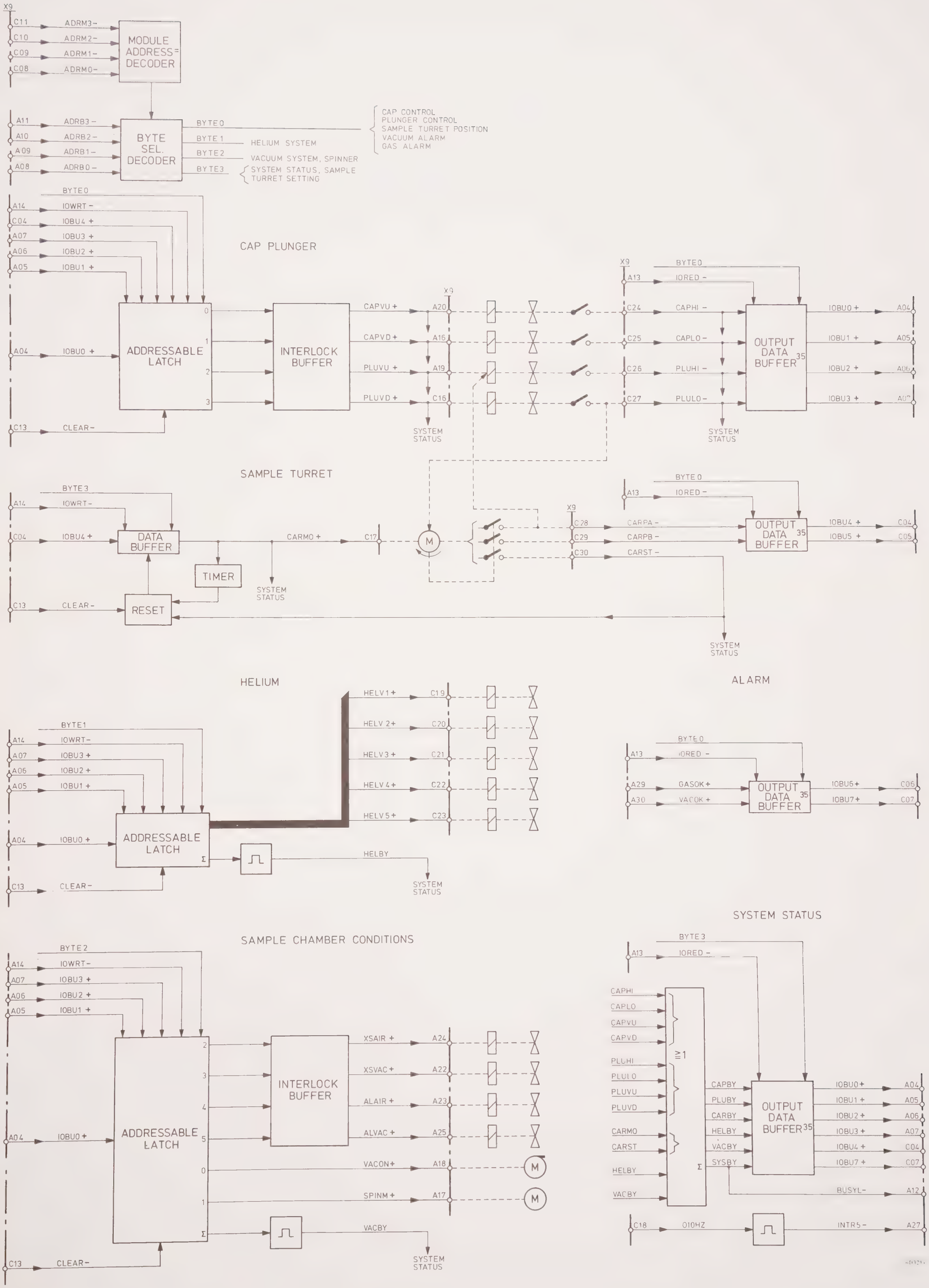


Fig. 4.7.1. Spectrometer Control 2 Blockdiagram

Busy signals for the cap and the plunger are both formed by combining the signal to start a movement with the status of the microswitch which indicates the end of the movement in or-gates, e.g. CAPVU– and CAPHI+ are combined in the or-gate D7–3 [F/26]. The outputs of the or-gates D7–3 and D7–4 are further combined in nand gate D8–3 [F/27], producing the signal CAPBY+. The signal PLUBY+ is produced in a similar way. These busy signals can be read by the microprocessor when it produces the commands IORED– = 0 and BYTE3– = 0.

The plunger and the cap unit also actuate microswitches S11, and S18 and S19 respectively, which complete the safety circuits [C/20]. If, for any reason, a situation exists where X-rays could pass through the loading opening (i.e. cap up and plunger down) the safety circuits will be broken, switching off both the X-ray tube power and the X-ray generator.

EQUIPMENT BUS

ADRESS SELECTION

CAP. PLUNGER

SAMPLE CHAMBER CONDITIONS

HELIUM SYSTEM

SAMPLE TURRET

ERROR TIMER

VACUUM PUMP MOTOR

SPECT CONT 1 [FIG 4.6.2 D/8]

OPEN = SWITCHED 12V LINE
CLOSED = SWITCHED 0V LINE

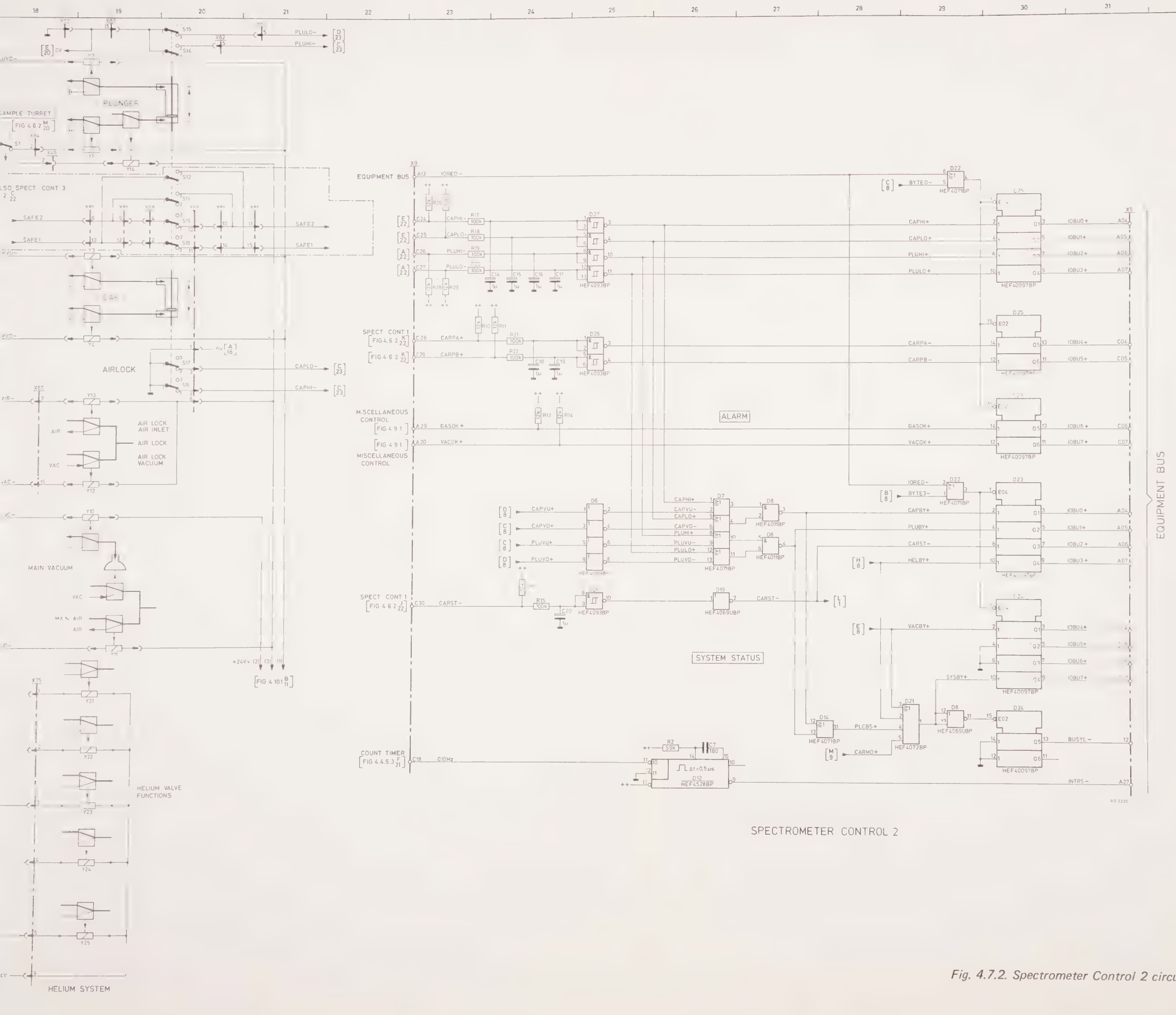
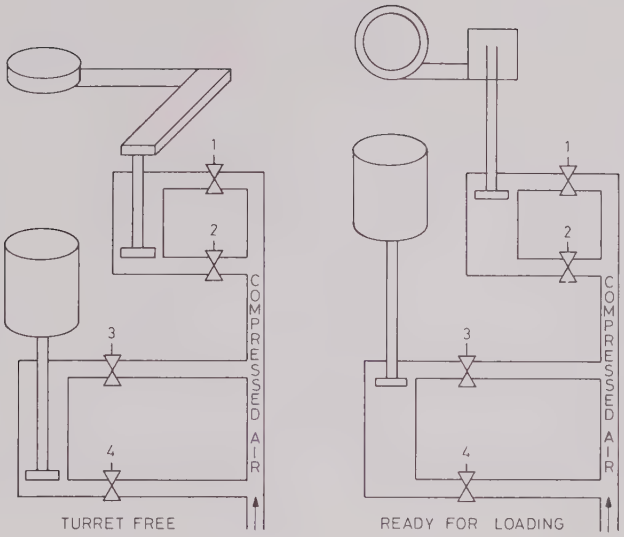


Fig. 4.7.2. Spectrometer Control 2 circuit diagram



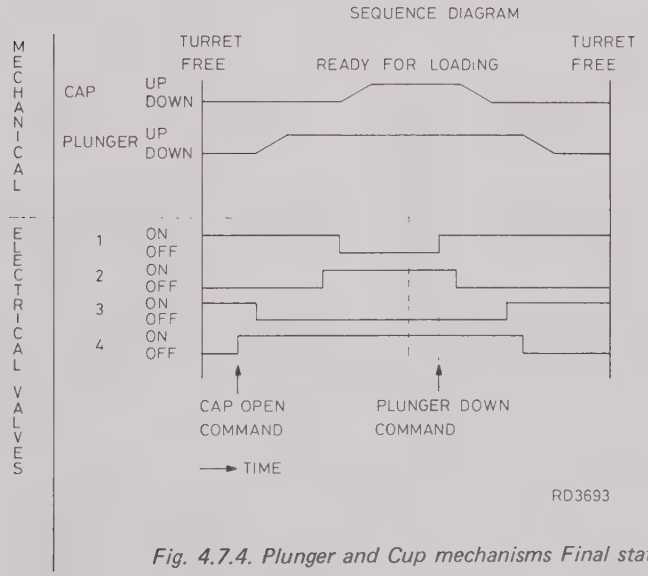


Fig. 4.7.4. Plunger and Cup mechanisms Final states

4.7.2. Sample turret

The sample turret buffer flip-flop D13 [K/3] is selected when the microprocessor issues the commands:

CLEAR– = 1
IOWRT– = 0
BYTE3– = 0

In this situation the signal CARST– has not triggered the one-shot D12–6 [L/2] and the timer D11 [L/5] is not producing a trigger pulse via the gates D4–10 [L/7] and D1–10 [L/3].

The flip-flop D13 [K/3] is set when IOBU4+ = 1.
This results in the signal CARMO+ = 1, causing the sample turret motor to run when the plunger shaft has actuated the microswitch S13.

CARMO+ = 1 directly triggers the busy line via the gates D21–1 and D8–11 [K/29], hence BUSYL– = 0.

When the sample turret motor moves out of the rest position the microswitch S2 is released, generating the signal CARST– = 1 [see fig. 4.6.2. J/22 and fig. 8.2.8.].
CARST– sets the buffer D23–7 [G/30] and triggers the one-shot D12–6 [L/2], causing the flip-flop D13 [K/3] to be reset. This results in CARMO+ = 0, and hence BUSYL– = 1 and CARST– = 0.

An error stop will be made by the error timer D11 [L/6] which produces a pulse after 12,8 seconds (W13 closed). This pulse is combined with a 10 Hz timing pulse in and-gate D4–10, thus resetting the flip-flop D13 and stopping the turret motor.

Fig. 8.2.8. shows the microswitches S3 and S4 which detect the sample turret position.
The status of these microswitches is decoded as follows:

TURRET POSITION	CARPA+ (S3)	CARPB+ (S4)
1	1	1
2	1	0
3	0	1
4	0	0

Actuated = 1
Released = 0

Both CARPA+ and CARPB+ signals are fed to the output buffer D25 [E/30] via the nand Schmitt triggers D26–3 and D26–4 [E/25]. The microprocessor can read the sample turret position from the output buffer D25 [E/30] by issuing the commands BYTE0– = 0 and IORED– = 0.

4.7.3. Sample chamber conditions (air, vacuum, spinner)

The sample chamber conditions are selected by the microprocessor via the addressable latch D18 [F/4] when the commands IOWRT– = 0 and BYTE2– = 0. These commands, combined in the or-gate D14–10 [E/3], are also used to trigger the one-shot D17–10 [E/6], which produces the 3 ms pulse VACBY+ = 1. This pulse sets the system status buffer D24–3 [J/30] and results in BUSYL– = 0 via D21–1, D8–11, and D24–13 [K/30].
The relevant flip-flops in the addressable latch D18 [F/4] are selected as follows:

	IOBU3+	IOBU2+	IOBU1+
VACON+ (A0)	0	0	0
SPINM+ (A1)	0	0	1
XSAIR+ (A2)	0	1	0
XSVAC+ (A3)	0	1	1
ALAIR+ (A4)	1	0	0
ALVAC+ (A5)	1	0	1

The flip-flops are set when IOBU0+ = 1 during the time that the address and selection is valid.
When VACON+ = 1 the vacuum pump motor is started via a solid relay (optocoupler/triac) V2 [E/12].

The spinner motor runs when SPINM+ = 1. This signal fires the triac V19 [Fig. 4.6.2. L/14]. The same signal is used to extinguish the LED "SPINNER" [fig. 4.6.2. L/9].

The signals XSAIR+, XSVAC+, ALAIR+ and ALVAC+ are applied to inverters D19 and and-gates = [D20], connected to provide an interlock circuit.
This interlock prevents the selection of vacuum and air at the same time. After buffering and inversion, these signals are used to control the valves Y1, Y10, Y12 and Y13 which govern the atmosphere in the spectrometer chambers.

4.7.4. Helium system

The valves of the helium system are controlled via the addressable latch D16 [H/4]. This latch is selected by the microprocessor with the signals

CLEAR – = 1
IOWRT– = 0
BYTE1– = 0

The signals IOWRT– and BYTE1– are combined in the or-gate D14-4 [H/3], and the combined signal enables the latch and triggers the one-shot D17-6. The one-shot produces a 3 ms signal pulse HELBY+ = 1 which is fed to the system status buffer D24-3 [J/30] and, via the or-gate D21-1 and the inverter D8-11, to the busy line buffer D24-13, where it produces BUSYL– = 0.

The status of the helium system can be read by the microprocessor issuing the commands IORED– = 0 and BYTE3– = 0.

The valves of the helium system are selected via the latch D16 [H/4] as follows:

	IOBU3+	IOBU2+	IOBU1+
HELV1+ (A4)	1	0	0
HELV2+ (A0)	0	0	0
HELV3+ (A1)	0	0	1
HELV4+ (A2)	0	1	0
HELV5+ (A3)	0	1	1

The signals are set into the latch when the microprocessor issues the signal IOBU0+ = 1.

The valves are controlled via the coil driver pcb's A31 and A32. These valves have the following functions:
Y21 – helium inlet valve to airlock
Y22 – helium outlet valve
Y23 – helium outlet valve from airlock
Y24 – helium inlet valve
Y25 – master compressed air valve for main helium valve

The operating sequence of these valves is given in chapter 5. (Helium system).

4.7.5. Alarm

An alarm situation exists whenever the detector gas flow is incorrect and whenever the vacuum in the spectrometer chambers is inadequate. The status of the detector gas and vacuum systems is obtained from sensors and the signals are processed on the miscellaneous control pcb.
The resulting signals GASOK+ and VACOK+ are fed to the alarm buffer D23 [F/30].

The status of these systems can be read by the microprocessor when it produces the signals IORED– = 0 and BYTE0– = 0.

4.7.6. System busy

As previously described, the buffers D23 [G/30] and D24 [H/30] contain the status of the cap, plunger, sample turret and medium (air, vacuum, or helium).

All the busy signals, in addition to being separately available via the buffers, are also combined via the or-gate D21-1 [J/30], producing the signal SYSBY+. This signal is applied to the buffer D24-9, where it can be read by the microprocessor when it issues the commands IORED– = 0 and BYTE3– = 0.

The signal SYSBY+ is also used to enable the buffer D24-13, so that SYSBY+ = 1 results in BUSYL– = 0 being fed to the common busy line.

The 10 Hz clock pulse train from the counter-timer pcb is applied to the one-shot D12-9 [K/26]. The one-shot produces a train of pulses of 0.5 μs width with a frequency of 10 Hz which is sent to the microprocessor as INTR5–.

4.8. GENERATOR AND DISPLAY CONTROL
(Spectrometer Control 3)

The control of the parameters affecting the X-ray generator, the control of the alphanumeric display, and the safety and switching on circuits, is carried out by the Spectrometer Control 3 pcb (see fig. 4.8.1. and 4.8.2.).

This pcb is addressed by the microprocessor by means of the "address of module" word /3xxx, (ADRM3–... ADRM0– = 1100 [fig. 4.8.2. A/2] .

The bytes detected on this pcb are:
/x0 (ADRB3– ... ADRB0– = 1111)
/x1 (ADRB3– ... ADRB0– = 1110)
/x2 (ADRB3– ... ADRB0– = 1101)
/x3 (ADRB3– ... ADRB0– = 1100)

The spectrometer control 3 pcb contains the following functions:
1. Display drive, decade selection, and display data.
2. Generator remote, kV and mA selection.
3. Generator ready.
4. Jumper selection.
5. Sample changer/counter-timer start buffer
6. Safety and switch-on circuits

The bit patterns required to control these functions are placed on the address bus and the input/output bus by the microprocessor. These are listed in the following table:

Spectrometer control 3, bit patterns

ADRM–	ADRB–	D7 ... D4 IOBU+	D3 ... D0 IOBU+	COMMENTS		
INFORMATION FROM MICRO PROCESSOR; ACCEPTED IF IOWRT– = 0.						
3	0	EVEN	0	SELECT	10 mA	
3	0	0	1	SELECT	15 mA	
3	0	2	2	SELECT	20 mA	
3	0	4	3	SELECT	25 mA	
3	0	8	4	SELECT	30 mA	
3	0	A	5	SELECT	35 mA	
3	0	C	6	SELECT	40 mA	
3	0	E	7	SELECT	45 mA	
3	0		8	SELECT	50 mA	
3	0		9	SELECT	55 mA	
3	0		A	SELECT	60 mA	
3	0		B	SELECT	65 mA	
3	0		C	SELECT	70 mA	
3	0		D	SELECT	75 mA	
3	0		E	SELECT	80 mA	
3	0	ODD	0	SELECT	25 kV	SETTINGS WITH PW1730/00/10 GENERATOR
3	0	1	1	SELECT	30 kV	
3	0	3	2	SELECT	35 kV	
3	0	5	3	SELECT	40 kV	
3	0	7	4	SELECT	45 kV	
3	0	9	5	SELECT	50 kV	
3	0	B	6	SELECT	55 kV	SETTINGS WITH PW 1732/10 GENERATOR
3	0	D	7	SELECT	60 kV	
3	0	F	8	SELECT	65 kV	
3	0		9	SELECT	70 kV	
3	0		A	SELECT	75 kV	
3	0		B	SELECT	80 kV	
3	0		C	SELECT	85 kV	
3	0		D	SELECT	90 kV	
3	0		E	SELECT	95 kV	
3	0		F	SELECT	100 kV	
3	1	X	EVEN	SELECT GENERATOR MANUAL CONTROL		
3	1	X	ODD	SELECT GENERATOR REMOTE CONTROL		

ADRM–	ADRB–	D7 ... D4 IOBU+	D3 ... D0 IOBU+	COMMENTS
3	3	X	0	ALPHANUMERIC DISPLAY BLANK
3	3	X	1	ALPHANUMERIC DISPLAY NOT BLANK
3	3	X	8	DRIVE DIGIT 1 ALPHANUMERIC DISPLAY
3	3	X	9	DRIVE DIGIT 2 ALPHANUMERIC DISPLAY
3	3	X	A	DRIVE DIGIT 3 ALPHANUMERIC DISPLAY
3	3	X	B	DRIVE DIGIT 4 ALPHANUMERIC DISPLAY
3	3	X	C	DRIVE DIGIT 5 ALPHANUMERIC DISPLAY
3	3	X	D	DRIVE DIGIT 6 ALPHANUMERIC DISPLAY

INFORMATION TO MICRO PROCESSOR; ACCEPTED IF IORED– = 0.

3	1	X	0	JUMPER SETTINGS NOT USED
3	1	EXCEPT	1	
3	1	0	2	
3	1		3	
3	1		4	
3	1		5	
3	1		6	
3	1		7	
3	1		8	
3	1		9	
3	1		A	
3	1		B	
3	1		C	
3	1		D	
3	1		E	
3	1		F	
3	1	1	X	GENERATOR NOT READY, SAMPLE CHANGER CONNECTED, SAMPLE UNDER CAP
3	1	3	X	GENERATOR NOT READY, SAMPLE CHANGER CONNECTED, SAMPLE NOT UNDER CAP
3	1	5	X	GENERATOR NOT READY, NO SAMPLE CHANGER CONNECTED, SAMPLE UNDER CAP
3	1	7	X	GENERATOR NOT READY, NO SAMPLE CHANGER CONNECTED, SAMPLE NOT UNDER CAP
3	1	9	X	GENERATOR READY, SAMPLE CHANGER CONNECTED, SAMPLE UNDER CAP
3	1	B	X	GENERATOR READY, SAMPLE CHANGER CONNECTED, SAMPLE NOT UNDER CAP
3	1	D	X	GENERATOR READY, NO SAMPLE CHANGER CONNECTED, SAMPLE UNDER CAP
3	1	F	X	GENERATOR READY, NO SAMPLE CHANGER CONNECTED, SAMPLE NOT UNDER CAP
3	2	X	0	JUMPER SETTINGS NOT USED
3	2	X	1	
3	2	X	2	
3	2	X	3	
3	2	X	4	
3	2	X	5	
3	2	X	6	
3	2	X	7	
3	2	X	8	
3	2	X	9	
3	2	X	A	
3	2	X	B	
3	2	X	C	
3	2	X	D	

3	2	X	E	
3	2	X	F	
3	2	X	X	
3	2	0	X	
3	2	1	X	
3	2	2	X	
3	2	3	X	
3	2	4	X	
3	2	5	X	
3	2	6	X	JUMPER SETTINGS NOT USED
3	2	7	X	
3	2	8	X	
3	2	9	X	
3	2	A	X	
3	2	B	X	
3	2	C	X	
3	2	D	X	
3	2	E	X	
3	2	F	X	

ADRM–	ADRB–	DATA D7 ... D4 IOBU+	BYTE D3 ... D0 IOBU+	COMMENTS CHARACTER	ASCII
3	2	C ,8,4,0	0	@	@
3	2	C 8,4,0	1	A	A
3	2	C ,8,4,0	2	B	B
3	2	C ,8,4,0	3	C	C
3	2	C ,8,4,0	4	D	D
3	2	C ,8,4,0	5	E	E
3	2	C ,8,4,0	6	F	F
3	2	C ,8,4,0	7	G	G
3	2	C ,8,4,0	8	H	H
3	2	C ,8,4,0	9	I	I
3	2	C ,8,4,0	A	J	J
3	2	C ,8,4,0	B	K	K
3	2	C ,8,4,0	C	L	L
3	2	C ,8,4,0	D	M	M
3	2	C ,8,4,0	E	N	N
3	2	C ,8,4,0	F	O	O
3	2	D , 9,5,1	0	P	P
3	2	D ,9,5,1	1	Q	Q
3	2	D ,9,5,1	2	R	R
3	2	D ,9,5,1	3	S	S
3	2	D ,9,5,1	4	T	T
3	2	D ,9,5,1	5	U	U
3	2	D ,9,5,1	6	V	V
3	2	D ,9,5,1	7	W	W
3	2	D ,9,5,1	8	X	X
3	2	D ,9,5,1	9	Y	Y
3	2	D ,9,5,1	A	Z	Z
3	2	D ,9,5,1	C	\	\
3	2	D ,9,5,1	D	α	] ^
3	2	D ,9,5,1	E	β	+
3	2	D ,9,5,1	F	γ	– (←)
3	2	E ,A,6,2	0	Sp.	Sp.
3	2	E ,A,6,2	1	test	!
3	2	E ,A,6,2	2	test	!
3	2	E ,A,6,2	3	a-g	#
3	2	E ,A,6,2	4	$	$
3	2	E ,A,6,2	5	%	%
3	2	E ,A,6,2	6	h-r	&
3	2	E ,A,6,2	7	'	'
3	2	E ,A,6,2	8	(	(
3	2	E ,A,6,2	9	)	)
3	2	E ,A,6,2	A	*	*
3	2	E ,A,6,2	B	+	+
3	2	E ,A,6,2	D	–	–
3	2	E ,A,6,2	F	/	/
3	2	F ,7,3	0	0	0
3	2	F ,7,3	1	1	1
3	2	F ,7,3	2	2	2
3	2	F ,7,3	3	3	3
3	2	F ,7,3	4	4	4
3	2	F ,7,3	5	5	5
3	2	F ,7,3	6	6	6
3	2	F ,7,3	7	7	7
3	2	F ,7,3	8	8	8
3	2	F ,7,3	9	9	9

IT IS POSSIBLE TO DISPLAY SELECTED CHARACTERS WITH THE USE OF A PROGRAM WRITTEN INTO THE RAM, OR BY CHANGING THE CONTENTS OF THE ADDRESSES AT WHICH ALPHANUMERIC CHARACTERS ALREADY BEING DISPLAYED ARE STORED.
SEE CHAPTER 7.1.12.

3	2	F 7,3	A	⩽	:
3	2	F 7,3	B	⩾	;
3	2	F 7,3	C	<	<
3	2	F 7,3	D	=	=
3	2	F 7,3	E	>	>
3	2	F 7,3	F	?	?

4.8.1. Display control

4.8.1.1. Introduction (fig. 4.8.1.)

The microprocessor generates a 6-bit ASCII code for a character, and this is written into a data buffer. Following this the microprocessor generates a 3-bit decade select code which is written into the decade address buffer. The contents of the data buffer are written into an address in a RAM, the address being selected by the contents of the decade address buffer. This process is repeated for each decade of the display. The 14-bit character generator, in which the RAM is contained, also contains a ROM in which the complete character set is stored. The 6-bit ASCII codes stored in the RAM now form the addresses in the ROM where the corresponding 14-bit alphanumeric characters are stored.

An oscillator produces a pulse train which triggers a counter. The output of the counter is applied to a digit selection decoder which, via an anode driver, energizes the anodes of the displays in sequence. The output of the counter is also applied to the scan address buffer, so that as each anode is selected, the appropriate address in the RAM where the address of the required character in the ROM is stored is also selected. Thus as each decade is selected in turn, at a frequency of 500 Hz, the appropriate character is displayed in that decade.

4.8.1.2. Display data (fig. 4.8.2.)

The data to be written into the RAMs is first stored in the latch D22 [F/3] thus freeing the I/O bus for decade selection. The latch is enabled when the microprocessor generates BYTE2– = 0 and IOWRT– = 0.
The data, in the form of a 6-bit ASCII code, is then available in the buffer D6 [E/9], from which it is fed to the RAMs D7 [B/13] and D8 [E/13] under the same conditions, and at the same time, as the decade selection which determines the address in the RAM at which the data will be stored.

4.8.1.3. Decade selection

The decade of the display in which the display data is to appear is selected on the lines IOBU0+ ... IOBU2+ via the buffers D24 [E/5]. The bit pattern required to select a decade is given in the following table. This results in the signals DSEL1+ ... DSEL3+.

Decade	IOBU2+	IOBU1+	IOBU0+
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1

The decade selection buffer D5 [D/9] is enabled at the same time as the data buffer D6 [E/9] when the microprocessor issues the commands:

IOBU3+ = 1
BYTE3– = 0
IOWRT– = 0

which result in DISWR+ = 1.

The signal DISWR+ = 1 also blocks the decade selection from the decade counters D3 [C/19] via the buffer D4 [B/9]. The rising edge of the signal DISWR+ = 1 triggers the one-shot which results in the data available at the output of the buffer D6 [E/9] being written into the RAMS D7 [B/13] and D8 [E/13] at the address selected by the signals DSEL1+ ... DSEL3+ available at the output of the buffer D5 [D/9]. In the period during which DISWR+ = 1 the output of the RAMs is blocked since this signal is applied to the output disable connections of the RAMs.

4.8.1.4. Display drive

The display is composed of two pairs of alphanumeric (14-segment) characters (decades 0-4) and one pair of numeric (7-segment) characters (decades 5 and 6). The common anodes of these displays are multiplexed at a scanning frequency of ≈ 500 Hz (i.e. anode-on time ≈ 2 ms).

The decades are scanned in a serial manner, each display cycle starting from the reset condition with decade 0. From the timing diagram figure 4.8.3. it can be seen that in each display cycle the sequence is such that the even-numbered decades (the right-hand half of each character pair) are illuminated, followed by the odd-numbered decades (the left-hand half of each character pair).

When the pcb is not being addressed by the microprocessor the signal DISWR+ = 0 [D/6]. The result of this is that the outputs of the data buffer D6 [E/9] and the decade selection buffer D5 (D/9] are floating. Also the one-shot D2 [D/11] is not triggered, so no write pulse is applied to the RAM's D7 [C/13] and D8 [E/13]. However, all the data previously stored in the RAM's is available at the outputs when the decade selection scanning signals from the display counters D3 [A-C/19] are applied to the RAM's as an address via the scan address buffer D4 [B/9].

At each RAM address a six-bit word (ASCII code) is stored. This word is put onto the ROM address bus. At each address pair in the ROM's a 14-bit word is stored. This word, which represents an alphanumeric character, is indicated in the table.

The input address to the ROM's is an 8-bit format, bits A1 to A6 determining the addresses of the alpha-numeric codes. Bit A0 is connected to +5 V on D10 [A/15] and to ground on D11 [D/15]; this bit determines whether the data is for display segments a to g (D10) or h to r (D11).

The decade selection scanning signals from the display counters D3 [A-C/19], together with the output of the oscillator D14 [A/18] are fed to a BCD-to-decimal decoder D9 [A/21].
The outputs from D9 are used to activate the displays in the same sequence as that in which associated RAM address is produced via the scan address buffer D4 [B/9]. Thus the appropriate character appears in each decade of the display.

4.8.1.5. Display blanking

The microprocessor can blank the display by issuing the commands:

IOBU0+ = 0
CLEAR– = 1

and the flip-flop D20 [H/3] will be reset by the positive-going edge of the clocking signal from D21–6 formed from the signals:

BYTE3– = 0
IOBU3+ = 0
IOWRT– = 0

thus producing the signal BLANK+ = 1 from D20-12.

The display will also be blanked by CLEAR– = 0, which will always reset the flip-flop D20 irrespective of any other signals which may be present.

The flip-flop will be set by the positive-going edge of the clocking signal from D21-6 formed from the signals:

BYTE3– = 0
IOBU3+ = 0
IOWRT– = 0

if the microprocessor has issued the commands:

IOBU0+ = 1
CLEAR– = 1

4.8.1.6. Display brightness

The display is built up in two parts, the segments a to g being stored in one ROM and the segments h to r in another. In order to obtain consistent overall display brightness the segment current supplied by each of the drivers served by the ROM's can be separately adjusted.

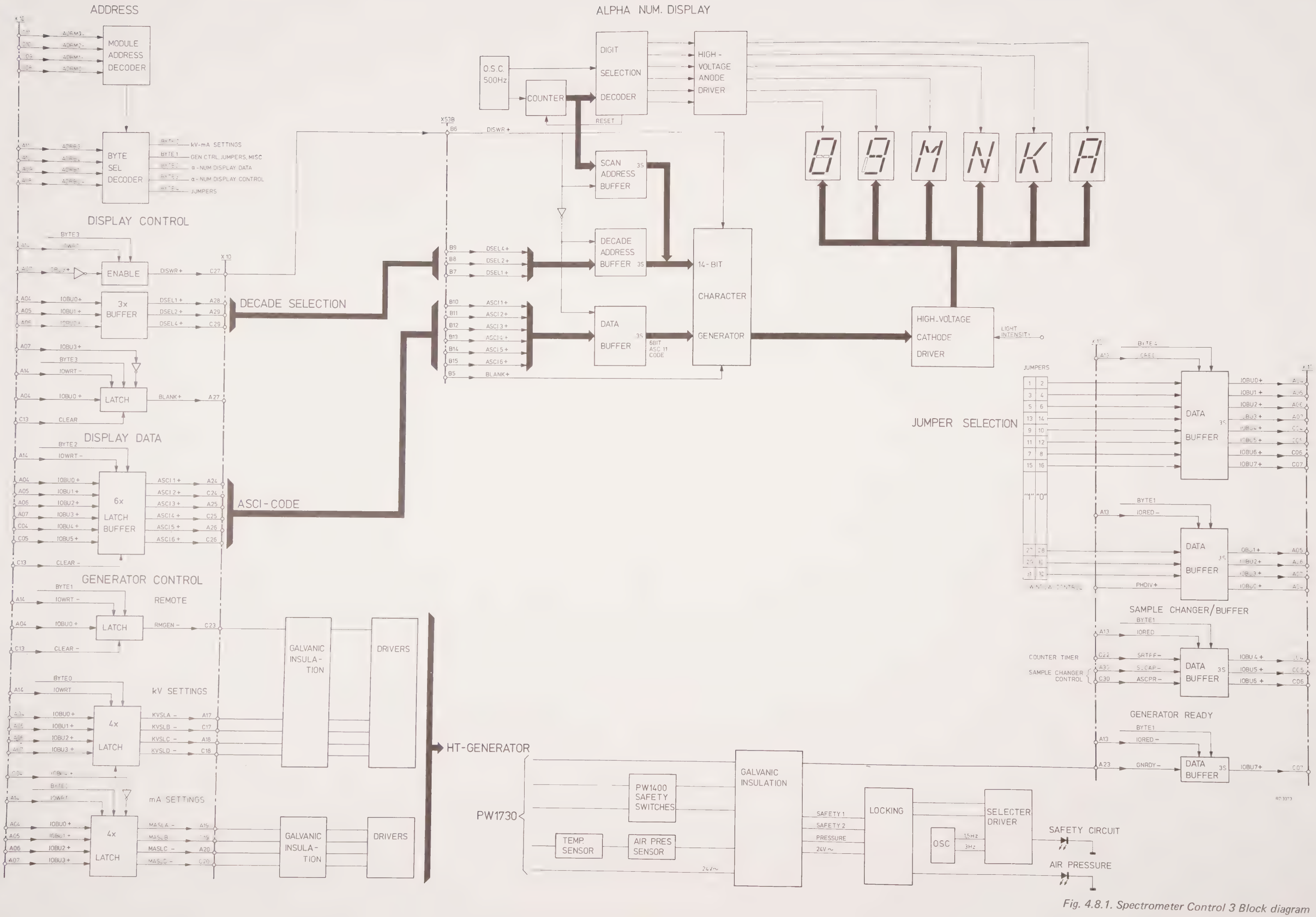


Fig. 4.8.1. Spectrometer Control 3 Block diagram

WARNING

The circuit on which measurements must be made is at a potential of 180 V. Switch off the spectrometer before connecting probes.

Connect the two 'Y' inputs of a double beam oscilloscope, one to each end of resistor R27 [B/24].

Switch on the spectrometer and set the test character "a-g" (hexadecimal code /23) into the display; the display must contain no other character (for this procedure see chapter 7.1.12.). Adjust the potentiometer R61 [A/16] until the voltage dropped over the resistor R27 [B/24] is 2.14 volts.

Set the test character "h-r" (hexadecimal code /26) into the display and adjust the potentiometer R62 [D/16] until the voltage over the resistor R27 [B/24] is again 2.14 volts.

4.8.2. Generator control

4.8.2.1. Remote

The PW 1730/10 series constant potential generators requires a general remote signal REMGN– = 0 before any remote control of the kV and mA settings is possible. This signal is generated when the flip-flop D29 [J/4] is set, which occurs on the positive-going edge of the signal from D19-4, formed from the microprocessor signals:

BYTE1– = 0
IOWRT– = 0

provided that:

IOBU0+ = 0
CLEAR– = 1

Similarly the flip-flop will be reset by the positive-going edge of the signal from D14-4 when IOBU0+ = 1. The flip-flop will always be reset by CLEAR– = 0 irrespective of any other signals which may be present.

The signal REMGN– is fed to the generator via a galvanic separation (optocoupler D9) and a driver V17.

4.8.2.2. kV settings

The kV latch D7 [K/5] is enabled when the microprocessor issues the commands:

BYTE0– = 0
IOWRT– = 0
IOBU4+ = 1

The kV selection signals appearing on the lines IOBU0+ ... IOBU3+ are then set into the latch and are fed to the generator via optocouplers D5 ... D8 and drivers V9, V11, V13 and V15.

4.8.2.3. mA settings

The mA latch D8 [L/5] is enabled when the microprocessor issues the commands:

BYTE0– = 0
IOWRT– = 0
IOBU4+ = 0

The mA selection signals appearing on the lines IOBU0+ ... IOBU3+ are then set into the latch and are fed to the generator via optocouplers D1 ... D4 and drivers V1, V3, V5 and V7.

4.8.2.4. Manual settings

The signal CLEAR– = 0 will reset the kV and mA latches D7 and D8, and the remote generator flip-flop D29. This results in:

REMGN– = 1
KVSLA– ... KVSLD– = 1
MASLA– ... MASLD– = 1

thus setting the generator for manual operation.

MODULE ADDRESS SELECTION

BYTE SELECTION

DISPLAY CONTROL

(RAM)

(RAM)

(ROM)

RI M

DIONICS

SWITCHING ON - AND SAFETY CIRCUIT

HT-GENERATOR SETTINGS

PW1730/..
HT_GENERATOR

FIG4.4.3

ALPHA NUM DISPLAY

STATUS

NOTE : JUMPER SELECTION NOT USED IN PW1400/..

WINDOW CONTROL

SAMPLE UNDER THE CAP CIRCUIT

SWITCHING ON - AND SAFETY CIRCUIT

SAFE 1

SAFE 2

PLUNGER

CAP

FRONT COVER

LOWER RIGHT HAND SIDE COVER

X-TAL CHAMBER

HT-CABLE

X-RAY TUBE

SAMPLE CHAMBER LEFT HAND SIDE

TOP COVER

FRONT COVER

UPPER REAR COVER

LOWER REAR COVER

AIR PRESSURE

SAFETY CIRCUIT

Fig. 4.8.2. Spectrometer Control 3 circuit diagram

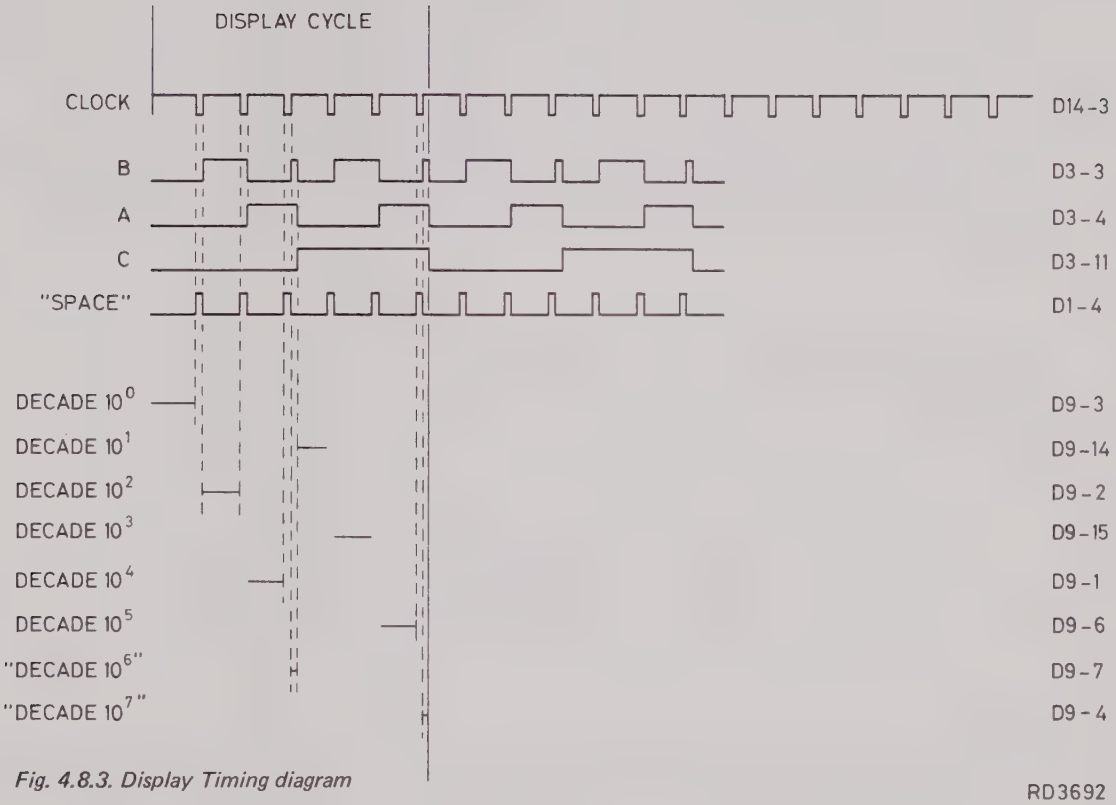
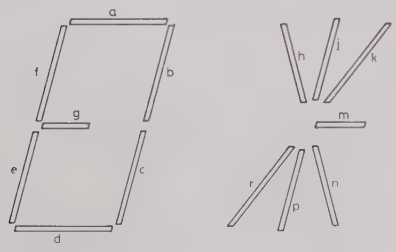


Fig. 4.8.3. Display Timing diagram



Display segments "a-g" Display segments "h-r"

Fig. 4.8.1.6. Display adjustment test characters

4.8.2.4. Generator ready

The PW 1730/10 series generators produce a signal GENRD– = 0 when the requested kV and mA settings have been made. This signal is fed via an optocoupler D10 [H/29] and an inverter D8 [H/36] to the output buffer D14-9 [H/36].

The contents of this buffer will be available on the IOBU lines when the microprocessor issues the command:

BYTE1– = 0
IORED– = 0

4.8.2.5. Jumper settings

The output buffers D4 [B/36] and D2 [D/36] can be used as a coder. If odd-numbered jumpers are closed the buffer flip-flops will be set, while if the even-numbered are closed the buffer flip-flops will be reset when the microprocessor issues the commands:

BYTE4– = 0
IORED– = 0

A similar arrangement is made for the buffer flip-flops D16-3, -5, -7, -9 [F/36], which will be either set or reset when the microprocessor issues the commands:

BYTE1– = 0
IORED– = 0

> **NOTE**
>
> In the PW 1400/00 jumper W1 must be closed (W2 open). The rest of this coding facility is not used. However it is important that all the jumpers be fitted to protect the ICs. The position of the jumpers (+15 V or ground) is not significant.

4.8.2.6. Sample changer/counter-timer start buffer

The signals STRFF–, SUCAP– and ASCPR– are applied to the output buffers D14 [H/36], while the signal PHDIV+ is applied to the output buffer D16 [F/36]. These signals are made available on the bus when the microprocessor issues the commands:

BYTE1– = 0
IORED– = 0

4.8.2.7. Switching on and safety circuits

An extract of the switching on and safety circuits from the PW 1730/10 series generators is included in fig. 4.8.2., between coordinates [F/15] and [M/18]. From this it can be seen that power can be supplied to the PW 1400/00 if the thermal cut out F1 in the generator, and the thermal cut out F3, and the compressed-air pressure sensor in the PW 1400/00 are all closed. If the MAINS ON pushbutton on the generator is pressed the relay Q1 will be energized.

To enable the mains to the generator to be switched on safety circuit 1 (SAFE 1), must be completed in the PW 1400/00. Similarly, to enable the kV and mA to be switched on, safety circuit 2 (SAFE 2) must be completed.

The PW 1400/00 has a display of the safety circuit conditions. The signals SAFE1+, SAFE2+, PRESS–, 24 V~, and 0 V are all fed, via optocouplers, to an interlock circuit formed from inverters D17 and nand gates D18 [H/31].

The resulting combined signals are used to enable the nand gates D2 [K/39]. Also applied to these nand gates are the 1.5 and 3.0 Hz outputs from an oscillator D3 [K/36]. Thus, if either or both of the safety circuits are broken, the LED B5 [L/39] will flash at the frequency given in the following table:

PRESS–	SIGNAL SAFE1+	SAFE2+	FLASH FREQUENCY OF LED B5
0	0	0	1.5 Hz
0	0	1	1.5 Hz
0	1	0	1.5 Hz
0	1	1	1.5 Hz
1	0	0	1.5 Hz
1	0	1	1.5 Hz
1	1	0	3.0 Hz
1	1	1	EXTINGUISHED

The signal PRESS– is also combined with the switched 24 V~ supply from the generator at D18–11 [K/31]. A fault condition (no, or insufficient pressure in the compressed air system) is displayed on the LED B4 [L/34].

4.9. MISCELLANEOUS CONTROL

The miscellaneous control pcb contains circuits for vacuum measurement, temperature stabilization, and gas leakage detection (see fig. 4.9.1.). The outputs of these circuits are displayed on a panel meter or with light emitting diodes, and are also used to limit the operation of the spectrometer if the required conditions are not reached.

4.9.1. Vacuum measurement

The vacuum measuring head contains two NTC resistors, one exposed to the vacuum in the spectrometer crystal chamber, and the other sealed in a glass tube. This second NTC forms a reference for the system. Both resistors are kept at a temperature of approximately 90 ^{o}C and are connected in similar bridge circuits containing operational amplifiers. The bridge supply voltage required to maintain the NTC at the required temperature is a measure of the vacuum.

The two bridge voltages are applied to logarithmic operational amplifiers, and the ratio of the two bridge voltages is obtained by algebraically adding the outputs of these amplifiers.

$$\text{ie} \quad \frac{T_1}{T_2} = \ln T_1 - \ln T_2$$

The ratio signal is passed to an operational amplifier D2-7 and thence via a switch S103A to the meter on the front panel.
The combined outputs of the logarithmic amplifiers are fed to an operational amplifier which provides an adjustable threshold and a second amplifier in series which drives a LED on the pcb.
This LED is illuminated when the pressure in the spectrometer is above the set point.
The circuit also provides a logic level signal VACOK+ for use as system status input.
A second LED on the front panel of the spectrometer is driven via an inverter and a transistor V4.

The vacuum measuring head is factory-tested and the voltages which are present at its connector pins for certain vacuum levels are engraved on it. If it is necessary to adjust the reading of the panel meter proceed as follows:

(a) Disconnect the vacuum measuring head

(b) Connect a power supply with voltmeter across X48 pins 8 and 9 adjust the voltage to be the same as U3 engraved on the vacuum measuring head.

(c) Connect a second power supply with voltmeter across X48 pins 7 and 8 and adjust the voltage to be the same as U2. Adjust the potentiometer R17 until the panel meter reads 100 Pascal.

(d) Set the voltage across X48 pins 7 and 8 to be the same as U1. Adjust the potentiometer R11 (CALIBRATE) until the panel meter reads 5 Pascal.

(e) Repeat steps (c) and (d) until both panel meter readings are correct. This is necessary because the adjustments are not independent of each other.

(f) Adjust the potentiometer R23 (THRESHOLD) until the LED's V9 and B3 are extinguished when the pressure registered on the panel meter is reduced to 30 Pascal. At pressures lower than this the signal VACOK+ = 1.

4.9.2. Temperature stabilization

The temperature in the spectrometer cabinet is measured with an NTC resistor mounted on the goniometer close to the lower-end-stop microswitch.
The temperature set point can be adjusted by means of a potentiometer R31 TEMPERATURE on the right hand side of the spectrometer. The approximate range of adjustment is 25-35 ^{o}C, the actual setting being made to give approximately equal heating and cooling cycles.

The dc output voltage of the NTC bridge circuit is compared with a 1 Hz oscillator voltage of triangular waveform. The difference voltage is used to obtain a time-proportional control of the heater, and the operation of the heater is indicated by the LED, "%", on the right hand side of the spectrometer, and by a LED on the pcb. When the temperature is within the linear control range (± 0,05^{o}C) the LED will flash with a frequency of 1 Hz.

Two additional circuits are used for controlling the cooling water circuits.
One circuit switches cooler 2 on when the duty cycle of the temperature control reaches 25% (coming from a higher value) and off when the duty cycle reaches 95% (coming from a lower value).

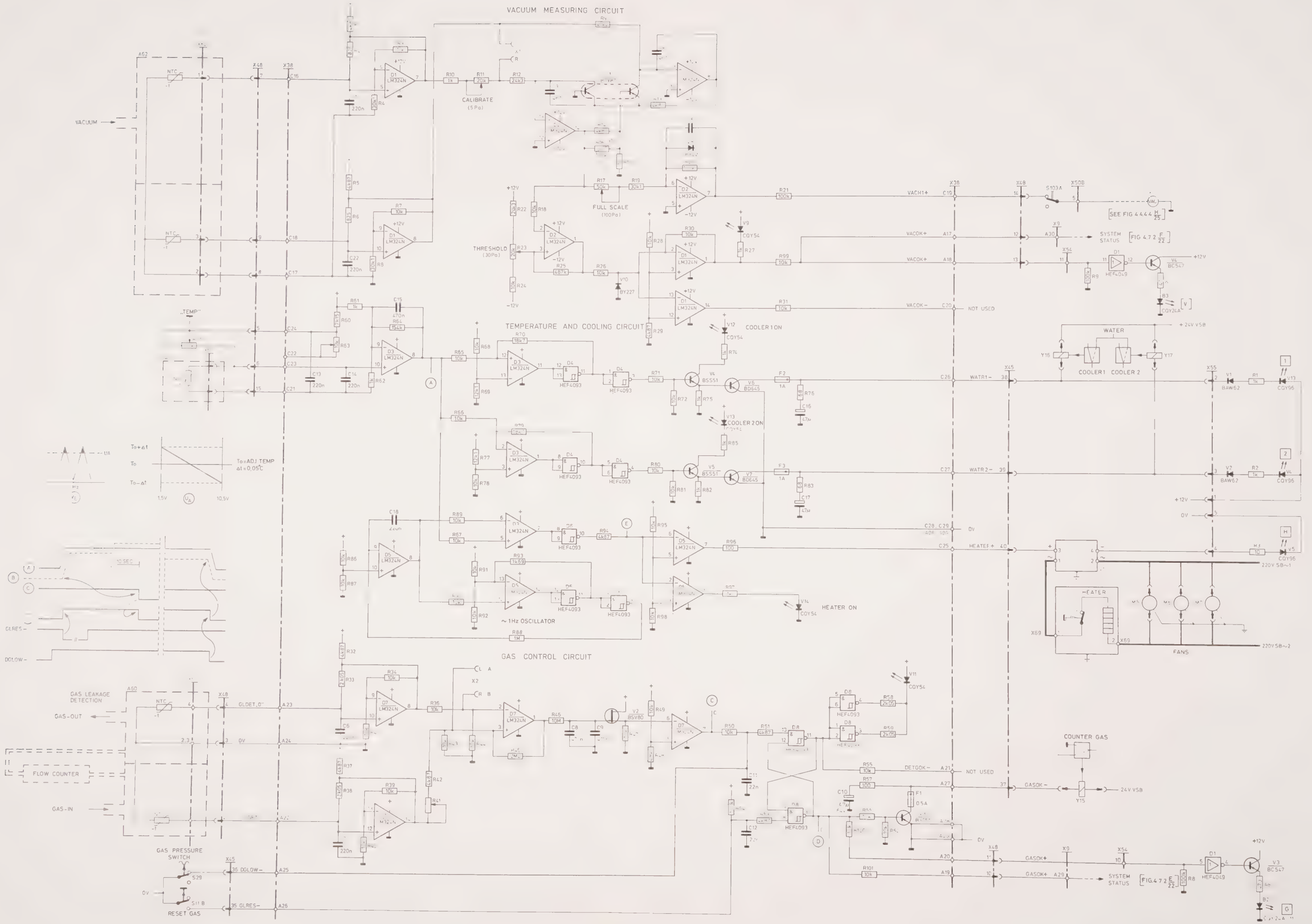


Fig. 4.9.1. Miscellaneous control circuit diagram

A second circuit switches cooler 1 in a similar way, but for a duty cycle of 5% and 75% respectively.
For both circuits LED's are illuminated on the pcb and on the right hand side of the spectrometer (C1 and C2) when the respective cooler is on.

4.9.3. Detector gas leakage indication and control

In the detector gas circuit two NTC resistors are placed in the gas flow, one at the input to the gas-flow detector and one at the output.
When the input and output flow rates are equal the gas supply valve Y15 is kept open.
When the difference in flow rates is six litres/hour or more, the gas supply valve is closed, and LED's on the pcb and on the front panel of the spectrometer are illuminated.

When the primary gas pressure is too low this is detected by a pressure switch, and the gas supply valve is closed by means of signal DGLOW–.

A logic signal GASOK+ = 1 when gas flow and pressure are normal. When a difference in flow rates, or a low primary pressure, is detected a flip-flop formed from D8-10 and D8-11 is set after a delay of ten seconds (R46, C8, C9) and the signal GASOK– = 1, resulting in the valve Y15 being closed and the gas supply being shut off. Also, GASOK+ = 0 results in the LEDs B2 and V11 being illuminated, and in measurements being prevented via the system status signals. This flip-flop can be reset by means of a push button switch S111B GAS LEAKAGE RESET on the right-hand side of the spectrometer.
It will also be necessary to operate this switch when the spectrometer is started up and each time the gas cylinder is changed.

The set point of the circuit is adjusted by means of potentiometer R41. This must be adjusted so that the flip-flop is set when the difference between the input and output gas flow rates is about 4-6 litres/hour.

4.10. POWER SUPPLIES

A circuit diagram of all the power supplies fitted in the PW 1400/00 is shown in Fig. 4.10.1. The connection of the power supplies to all printed circuit boards, together with the filters fitted on those pcb's is shown in fig. 4.10.2.

The 220 Vac mains supply is fed via two fuses F1 and F2 mounted on a panel in the PW173./10 generator [fig. 4.10.1. E/1], to the input terminals, X101 of the PW 1400/00. Whenever the mains supply is connected the following standby supplies are present: 24 V~ 1, 2 and 3; +32 V PA; +24 V SB; +12V SB; 220V SB ~ 1, and ~ 2 for the heaters and fans. This means that in the standby situation the status of the PW 1400/00 is as follows:

- Temperature stabilization system working
- Vacuum system sealed with plunger 'up'
- Standby battery for RAMs being charged
- Detector-gas leakage detector system working
- Detector pre-amplifier power supplies active
- Safety display active

All other supplies become available when the PW 173 . /10 mains on pushbutton is pressed.

4.10.1. Power supply PE 1271/00 (+5 V, −0 + 0.5 %)

See circuit diagram fig. 4.10.1.

Technical data

General

Safety	In accordance with I.E.C. 348, safety class I
Test voltage	Every unit has been factory tested between electrical circuit and heatsink with an a.c. voltage of 500 V
Output terminals	Floating with respect to earth. 60 V⎓ is the maximum permissible voltage between any one of the output terminals and heatsink. The "+" or "−" output may be connected to the heatsink if desired.
Radio interference	When transformer PE 1368, PE 1369 or PE 1370 is used then according to VDE 0875 below the K curve.

Input

Voltage	Applies for output voltages and output currents as adjusted at delivery. For other values of the input voltage, see application note. 10.5 V at full load With transformer PE 1368 110-127-220-237 V
Frequency	48.5 to 63 Hz
Consumption – PE 1271	32 VA

Output

a. As constant voltage stabiliser

Voltage range	On delivery adjusted to 5 V −0 +0.5 % Adjustable from 2 V to 9 V, see application note
Current range	2 A at 5 V, T amb. 55 °C convection cooling, for another value of T amb see fig. 4.10.
Output effects: (Stability related to static operation) 1. combined source voltage and load effect	⩽ 0.1 % at ± 10 % input voltage variations and 0 ⇌ 100 % I_{nom}.

2. temperature coefficient	⩽ 0.02 % per K from the adjusted output voltage
3. periodic and random deviation (PARD)	Peak to peak value ⩽ 1 mV. Bandwidth 50 MHz
4. drift	Typical 0.1 %/1000 hrs.
Dynamic operation:	
1. transient recovery time	⩽ 50 μs for a step change from 80 % full load to full load and a frequency of: 0.1 kHz ⩽ 0.01 Ω 1 kHz ⩽ 0.01 Ω 10 kHz ⩽ 0.15 Ω 100 kHz ⩽ 0.1 Ω 200 kHz ⩽ 0.2 Ω
Protection	– current limiting by fold back characteristic – fuse 2.6 A fast – overvoltage protection (optional)

b. Current limiting

Current limitation	2.28 A to 1.2 A adjustable with R19 On delivery adjusted to 2.28 A ± 0.08 A at 25 °C	At $T_{amb.} > 55$ °C the current limitation must be readjusted
Temperature coefficient of the current limitation	–6 mA/K	
Cross-over point	Automatic. See output characteristic Fig. 4.10.	

c. Parallel connection

The outputs of three units may be connected in parallel.

Environmental conditions

The environmental data are valid only if the instrument is checked in accordance with the official checking procedures.
Details on these procedures and failure criteria are supplied on request by the Philips Organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.

Ambient temperature

– Specified operating temperature	0 ... +55 °C
– Operating temperature	–10 °C ... +70 °C
– Storage and transport	–40 °C ... +70 °C

Humidity

– Operating range	10 % ... 80 % non condensing
– Storage and transport	5 % ... 95 % non condensing
Air circulation speed	0 ... 5 m/s
Cooling	By natural air circulation

Vibration

– Operating range	5 Hz/0.1 mm ... 60 Hz/0.01 mm
– Storage and transport	up to 150 Hz with accelerations of 50 m/s^2 max.

Bumps

– Operating range	(Acc./duration) 2.5 m/s^2/60 ms ... 10 m/s^2/10 ms
– Storage and transport	(Acc./duration) 50 m/s^2/16 ms ... 200 m/s^2/2 ms

Mechanical data

Dimensions	
– Height	100 mm
– Width	42 mm (9T) 48 mm with front panel or crowbar (10 T)
– Depth	168 mm
Mass	0.3 kg

Accessories

Operating manual
Mounting material for front panels

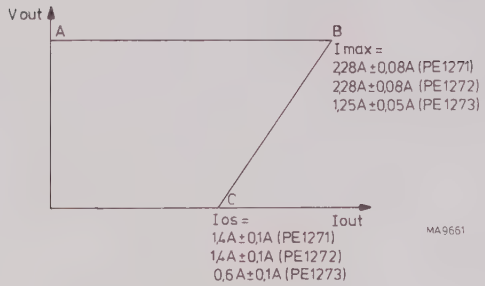
Accessory fitted:
Crowbar protection PE 1379 (2 to 10 V)
Application note 9499 150 09001

CONNECTIONS

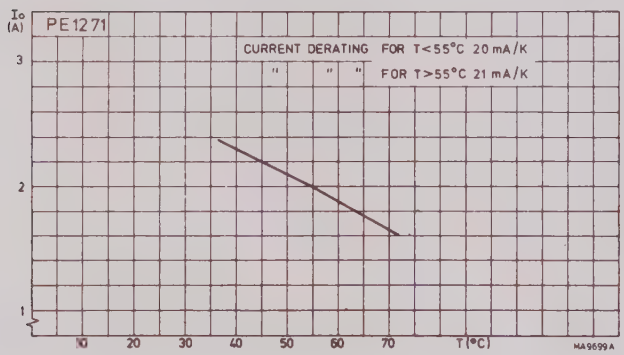
X101 (DIN 41612)	32 pole connector Maximum permissible current per terminal: 1 A
– A30, A32, C32	Earth connection
– A2, C2, A4, C4, A6, C6, A8	"~" input terminals
– C8, A10, C10, A12, C12, A14, C14	"~" input terminals Minimum four terminals per pole must be used
– A16, C16, A18, C18	"+" output terminals
– A26, A28, C28, C30	"–" output terminals Minimum two terminals per pole must be used.
– A20, A24	"+" respectively "–" sense. **Terminals A20 and A24 must be connected to the "+" and "–" output respectively if remote sensing is not used.**
– A22, A24	Remote ON-OFF (not used)
– C20, C22, C24, C26	May not be used for connections
X102 - X103	"+" and "–" terminal respectively to connect an overvoltage protection crowbar PE 1379 (2 to 10 V)
R119	Adjustment of the output current limitation to a value between: 2.28 A and 1.2 A see characteristic in Fig. 4.10.
F101	Fuse 2.6 A fast
A	Mounting hole for overvoltage protection (see Fig. 4.10.1.1)
B-B	Screw holes (M3) to fix mounting plate "F" if a front panel is used.

Remark

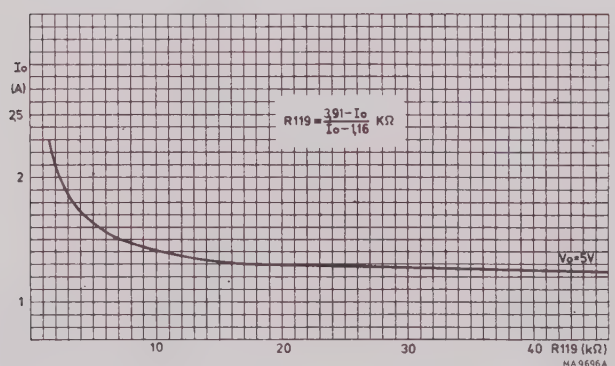
Application notes for Eurocards are available under code number 9499 150 09001 from the Philips organization in your country or from N.V. PHILIPS' GLOEILAMPEN-FABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.



Voltage Protection Curve



Current Derating Curve



Choice of Value for R 119

Fig. 4.10 Characteristics PE 1271/00

MAINS IN

PW 173 /10

GROUND

HEATERS + FANS

VACUUM PUMP

SAMPLE CHANGER

SEE POINT J 3

SPECT CONTROL 1, 2, 3 (SEE FIG 4.6.2 - 4.7.2 - 4.8.2)

HELIUM SYSTEM (SEE FIG 4.7.2)

GAS VALVE Y15

VALVES COOLING Y16 - Y17

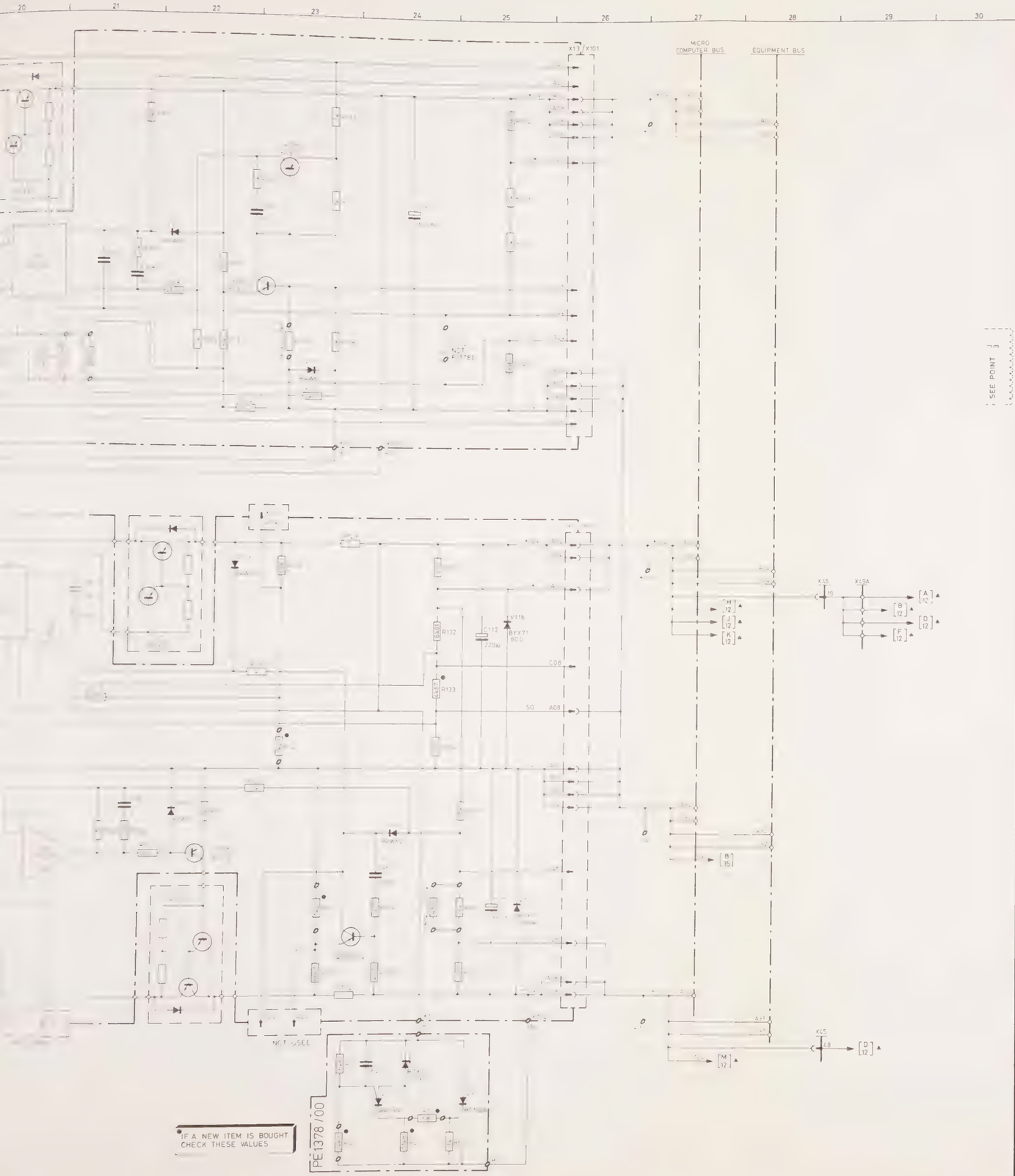
PE1813/00

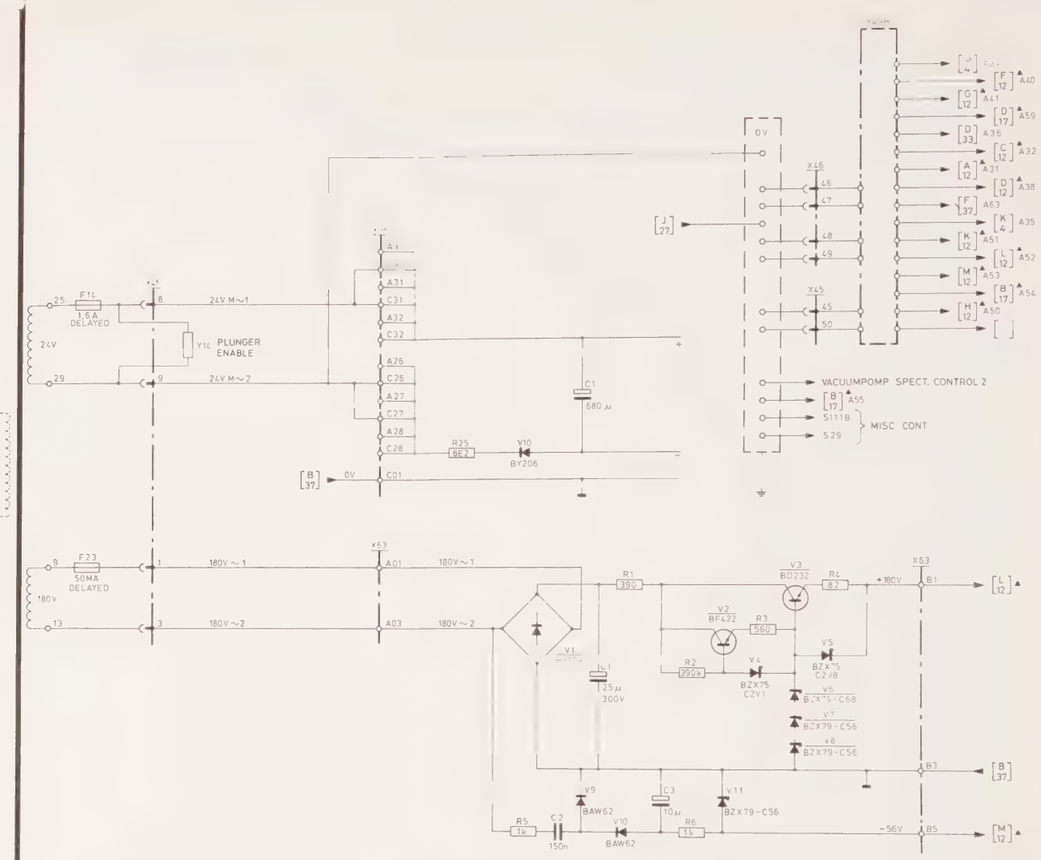
PE1379/00

PE1271/00

PE1379

PE1274/00





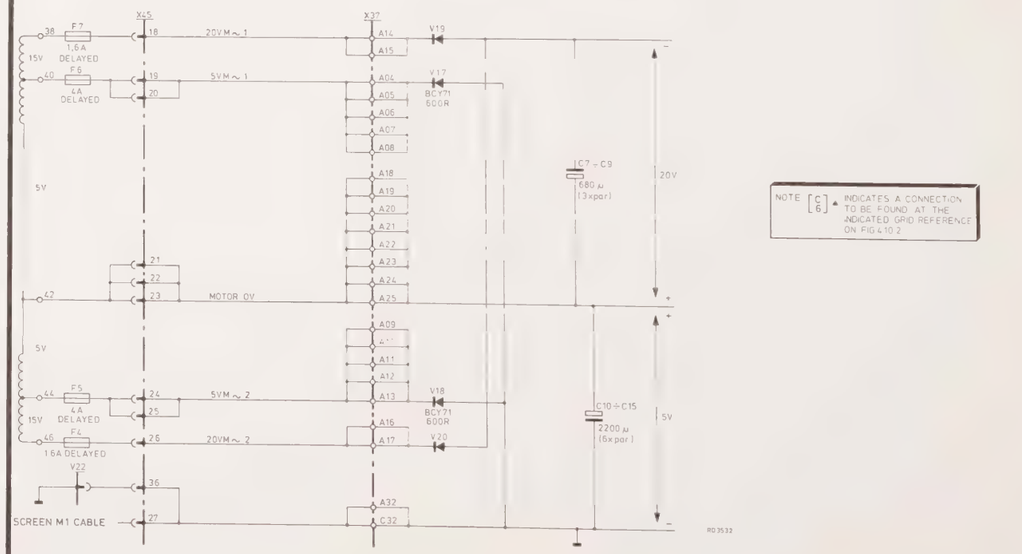


Fig. 4.10.1. Power Supplies circuit diagram

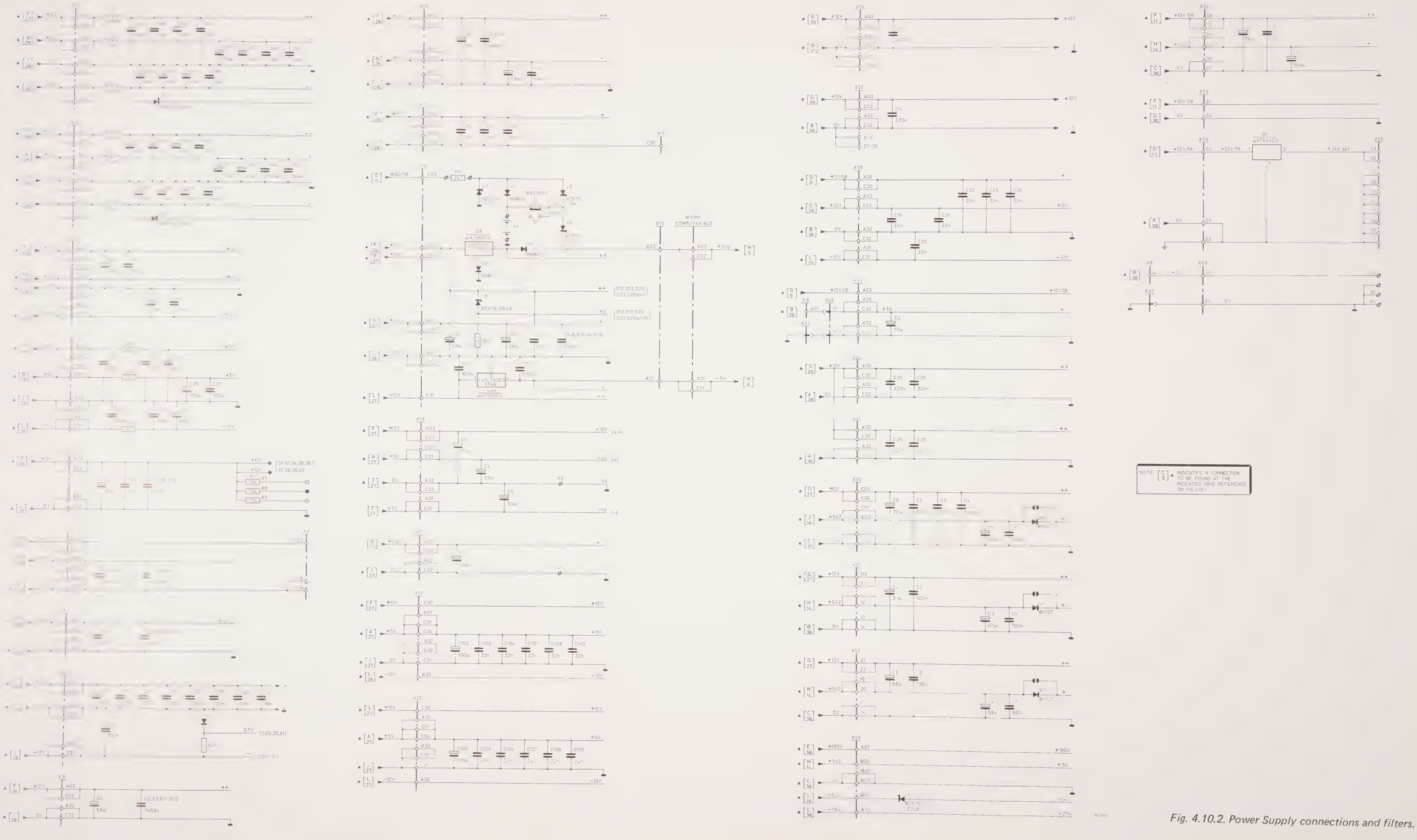


Fig. 4.10.2. Power Supply connections and filters.

4.10.1.1. Crowbar (overvoltage protection) PE 1397/01

See circuit diagram fig. 4.10.1 and fig. 4.10.1.1.1.

General

The crowbar provides protection against any output overvoltage condition which might occur because of operation error, or failure within the power supply or load.

Technical data

Trip voltage	Adjustable from 6 V to 10 V On delivery adjusted at 6 V (−450mV/+300mV)
Temp. coefficient of trip voltage	−3.7 mV/K
Operation time	Without C51 0.5 μs With C51 see Fig. 4.10.1.1.5.
Power consumption	10.5 mA - at input voltage of 5 V
Max. rated current	4.25 A
Operating temp.	0 ... 70 °C
Dimensions	Length 39,4mm - width 30,5mm - height 15mm
Mass	0,010 kg

Direction for use

Assembling and connecting operations

The overvoltage protection PE 1379 can be mounted with a screw M3 on the power supply Eurocard PE 1271, see leaflet 9499 150 08701; 9499 150 09101.

Adjustment of trip voltage

Adjustment is possible through changing the resistors R51 and R53.
The typical value of R51 is

$$\frac{443}{Vt - 5{,}4} \text{ Ohm}$$

(Where Vt is the required trip voltage in volt at an ambient temperature of 25 °C) see fig. 10.1.1.4.
Value of the power dissipation of R51 if

Power dissipation $Vt \leqslant 7V$: 0,33W (CR25) $7V < Vt \leqslant 10V$: 0,5W (CR37)

The current of GR51 needs to be adjusted (R53) as follows:

if Vt =	6 V	6 to 7 V	7 to 9 V	9 to 10 V
R53 =	120 Ω	150 Ω	330 Ω	470 Ω

NOTE
Resetting is possible by interrupting the mains voltage to the power supply with a crowbar protection.

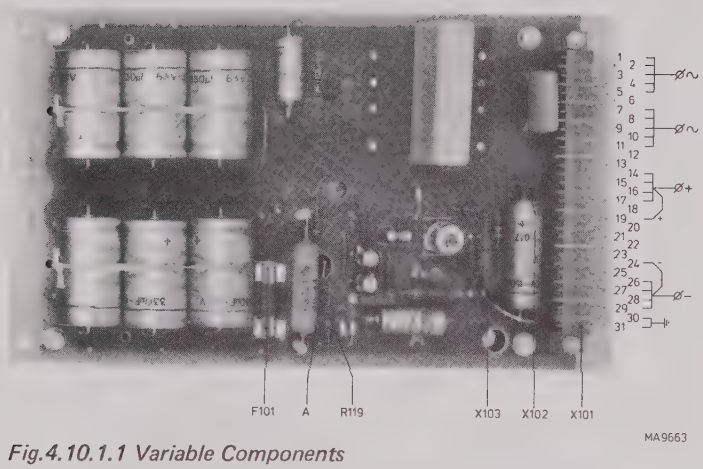


Fig.4.10.1.1 Variable Components

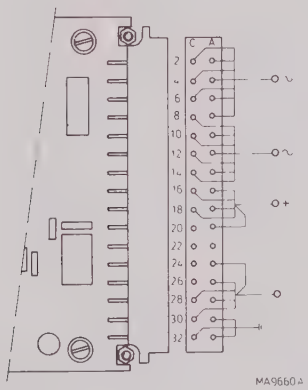


Fig. 4.10.1.2 Connections

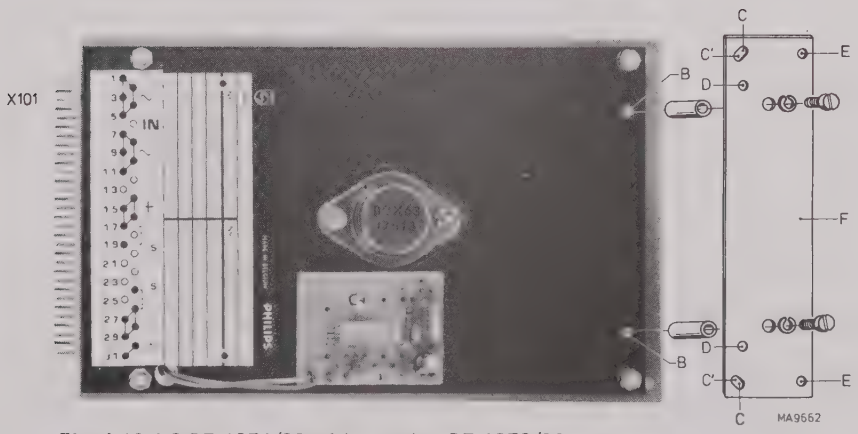
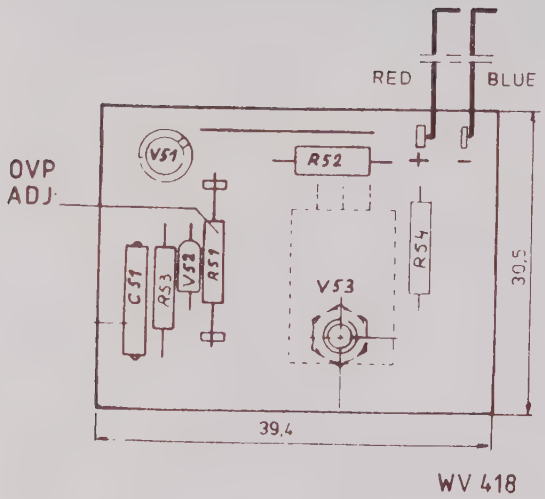


Fig. 4.10.1.3 PE 1271/00 with crowbar PE 1379/00



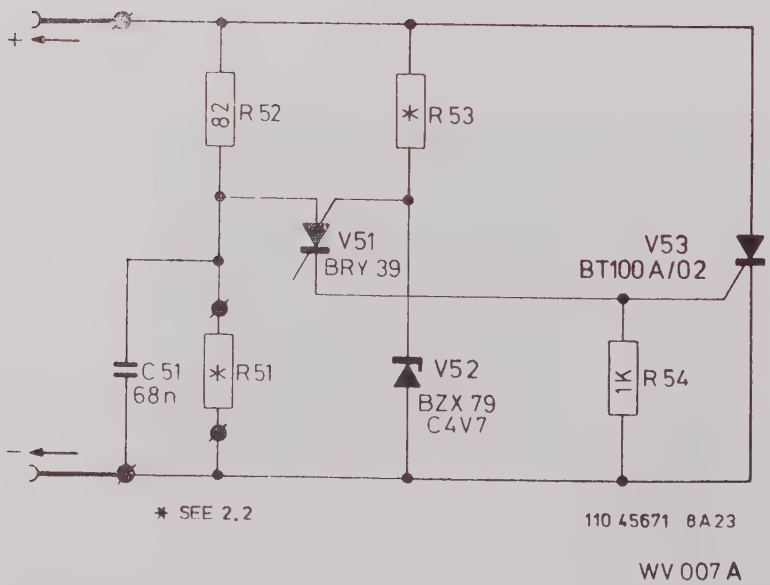


Fig. 4.10.1.1.1. Circuit diagram

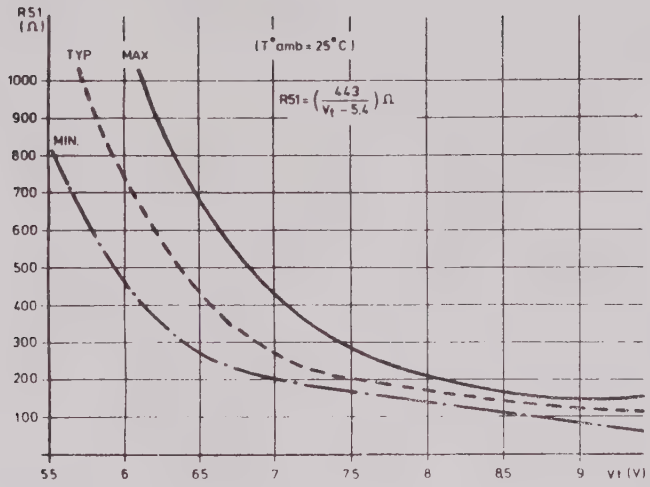


Fig. 4.10.1.1.4. Adjustment curve

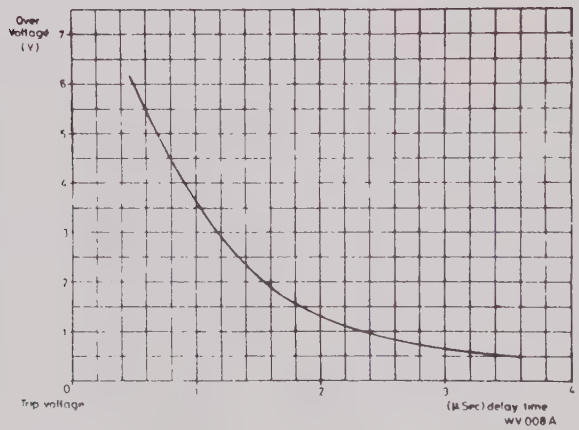


Fig. 4.10.1.1.5. Operation time

4.10.2. Power supply PE 1274/00 (+15 V, −0 +0.5 % and −15 V −0 +0.5 %)

See circuit diagram fig. 4.10.1.

Technical data

General

Safety	In accordance with I.E.C. 348, safety class I.
Test voltage	Every unit has been factory tested between electrical circuit and heatsink with an a.c. voltage of 500 V.
Output terminals	Floating with respect to earth. The maximum permissible d.c. voltage between any one of the output terminals and heatsink is 60 V. The "+", the "−" or the "0" output may be connected to the heatsink.
Radio interference	If transformer PE 1371 is used then according to the VDE 0875 below the K curve.

Input

A.C. voltage	2x20 V at full load. With transformer PE 1371, 110-127-220-237 V. Applies for output voltages and output currents as adjusted at delivery. For other values of the input voltage, see application note.
Frequency	48.5 to 63 Hz
Consumption	76 VA

Output (double polarity)

a. As constant voltage stabiliser

Voltage	On delivery adjusted to +15 V −0 +0.5 %and −15 V −0 +0.5 % with respect to the common zero point. Adjustable between +4 V and +16 V and between −4 V and −16 V.
Current range	1.1 A for +15 V and 1.1 A for −15 V at Tamb 55 °C convection cooling For another value of Tamb see Fig. 8.
Output effects: (Stability related to static operation)	
1. Source voltage effect	⩽ 0.1 % at ± 10 % input voltage variations.
2. Load effect	⩽ 0.1 % at load variations from no load to full load.
3. Temperature coefficient	⩽ 0.02 % per K from the adjusted output voltage.
4. Periodic and random deviation (PARD)	⩽ 2 mV peak to peak value. Bandwidth 50 MHz.
5. Drift	Typical 0.1 %/1000 hrs.
Dynamic operation:	
1. Transient recovery time	⩽ 50 μs for a step change from 80 % full load to full load and vice versa, and a $\frac{di}{dt} \leqslant 1 A/\mu s$.
2. Output impedance	For sinusoidal load variations of 80 % from full load to full load and a frequency of: 0.1 kHz ⩽ 0.004 Ω 1 kHz ⩽ 0.01 Ω 10 kHz ⩽ 0.11 Ω 100 kHz ⩽ 0.13 Ω 200 kHz ⩽ 0.13 Ω

Protection	– Current limiting by fold back characteristic. The current limiting protects both outputs. This means that, in case of current limiting of one output, the voltage of both outputs decreases automatically (dual tracking). – Fuses 2x1,6 A fast. – Overvoltage protection (optional).

b. Current limiting

Current limitation	1.25 A to 0.7 A adjustable with R117 for the negative output and with R121 for the positive output. On delivery adjusted to 1.25 A ± 0.05 A at 25 °C
Temperature coefficient of the current limitation	Typical –6 mA/K
Cross-over point	Automatic for both outputs. See output characteristic Fig. 4.10.

Environmental data

The environmental data are valid only if the instrument is checked in accordance with the official checking procedures.
Details on these procedures and failure criteria are supplied on request by the Philips Organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.

Ambient temperature

– specified operating temperature	0 ... +55 °C
– rated range of operation	–10 ... +70 °C
– storage and transport	–40 ... +70 °C

Humidity

– operating range	10 % ... 80 % non condensing
– storage and transport	5 % ... 95 % non condensing
Air circulation speed	0 ... 5 m/s
Cooling	By natural air circulation.

Vibration

– operating range	5 Hz/0,1mm ... 60 Hz/0,01mm
– storage and transport	up to 150 Hz with accelerations of 50m/s^2 max.

Bumps

– operating range	(acc./duration) 2.5 m/s^2/60 ms ... 10 m/s^2/10 ms
– storage and transport	(acc./duration) 50 m/s^2/16 ms ... 200 m/s^2/2 ms

Mechanical data

Dimensions	
– length	100 mm
– width	42 mm (9T) 48 mm with front panel or crowbar (10T)
– height	168 mm
Mass	0.3 kg

Accessories

– operating manual
– mounting material for front panels

Accessory fitted

Transformer PE 1371.
Crowbar protection PE 1378 (10 V to 28 V)
Application note 9499 150 09001.

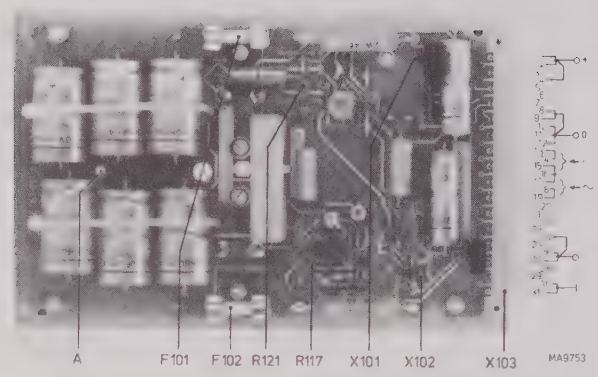


Fig. 4.10.2.1. Variable components

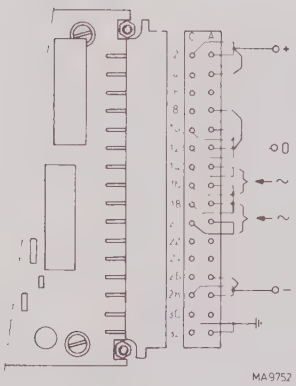


Fig. 4.10.2.2. Connections

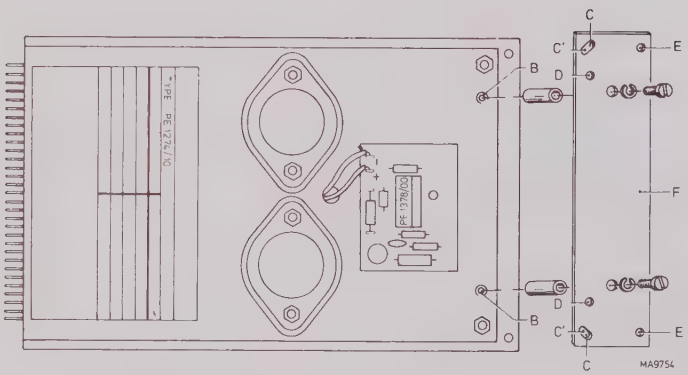


Fig. 4.10.2.3. PE1274/00 with crowbar PE1378/00

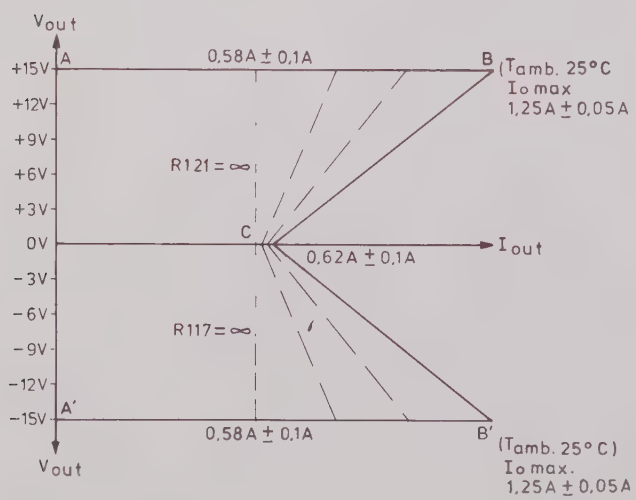


Fig. 4.10.2.4. Adjustment curves

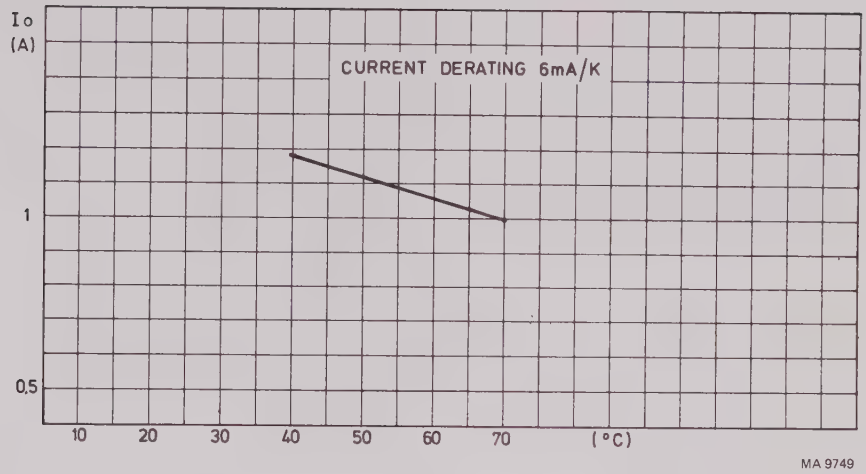


Fig. 4.10.2.5. Current derating curve

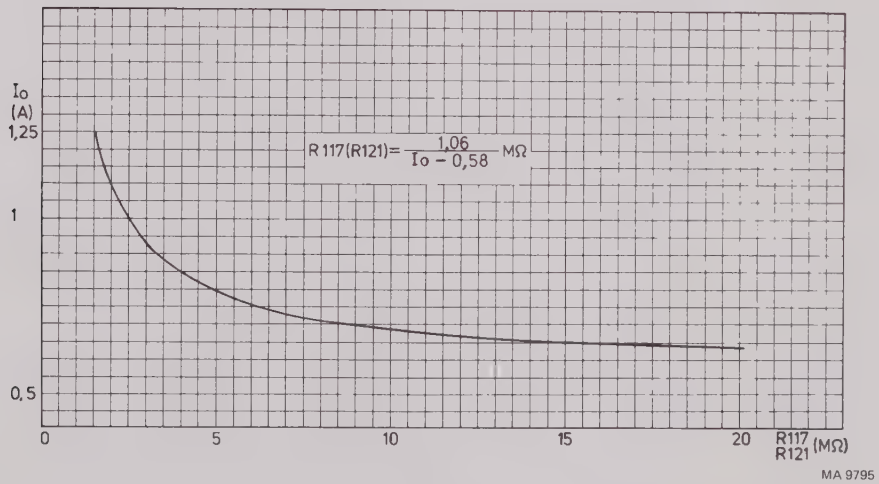


Fig. 4.10.2.6. Current limiting curve

CONNECTIONS

X103 (DIN 41612)	32-pole connector of the PE 1274/00 version (Fig. 4.10.2.2.) **Maximum permissible current per terminal: 1A**
– A2, C2	"+" output terminals
– A4	"+" sense terminal
– C4, A6, C6	May not be used for connections
– A8	"0" sense terminal
– C8	May not be used for connection
– A10, C10, A12, C12	"0" output terminals (common zero point)
– A14, C14	"~" input terminals
– A16, C16	Common zero point "~" input terminals
– A18, C18	
– A20, C20	"~" input terminals
– A22, C22, A24	May not be used for connections
– C24	Together with A8 for remote on-off (not used)
– A26	"–" sense terminal
– C26	May not be used for connection
– A28, C28	"–" output terminals
– A30, C30	Are not used
– A32, C32	Earth connection **Remark:** If remote sensing is not used, the sense terminals A4, A8 and A26 must be connected to the "+", "0" and "–" output terminals respectively.
X101, X102	"+" and "–" terminals respectively to connect an overvoltage protection PE 1378 (10 V to 28 V)
R117	Adjustment of the current limitation for the negative output between 1.25 A and 0.7 A see Fig. 4.10.2.6.
R121	Adjustment of the current limitation for the positive output between 1.25 A and 0.7 A see Fig. 4.10.2.6.
F101	Fuse 1.6 A fast for the positive circuit
F102	Fuse 1.6 A fast for the negative circuit
A	Mounting hole for overvoltage protection see Fig. 4.10.2.1.
B-B	Screw holes (M3) to fix mounting plate "F" if a front panel is used see Fig. 4.10.2.3.

Remark:
Application notes for Eurocards are available under code number 9499 150 09001 from the Philips organization in your country or from N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.

4.10.2.1. Crowbar (overvoltage protection) PE 1378/00

See circuit diagram fig. 4.10.1.

In order to protect the load against too high voltages, an overvoltage protection PE 1378 can be mounted, by means of a screw (M3) against the inside of the front panel.
For mounting and connection, see fig. 4.10.2.1.1.
The trip voltage is adjustable with R52 and R55 (fig. 2).
The value of R52 is: $(1.08 . V_t - 6.8)$ kΩ.
V_t is the trip voltage in volts (ambient temperature: 25 °C). See also characteristic fig. 3.
A certain tripping area can be adjusted with R55.
The value of R55 is: 20 Ω if V_t is lower than 11.5 V
68 Ω if V_t is between 11.5 and 23 V
430 Ω if V_t is between 23 and 28 V
Upon delivery the overvoltage protection is adjusted to V_t = 16.2 V + or −0.7 V.

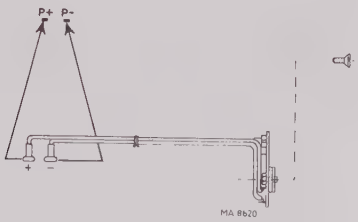


Fig. 4.10.2.1.1 Connections

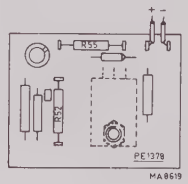


Fig.4.10.2.1.2 Layout

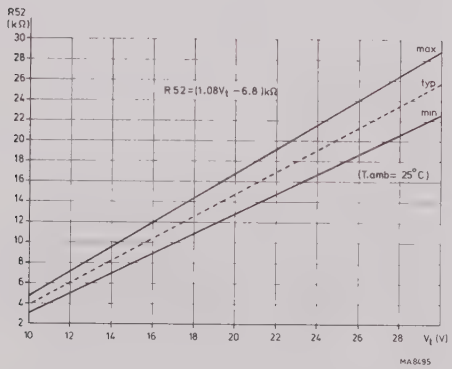


Fig. 4.10.2.1.3 Adjustment curves

4.10.3. Power supply PE 1813/00 (+5 V, −0 +0.5 %)

See circuit diagram fig. 4.10.1.

The PE 1813/00 is basically the same as the PE 1271/00 with the following component differences to enable the power supply to deliver 4 Amp.

V101 = 3 x 3.2/2.2 A

V1 = BDX67

F101 = 5 A fast

R114 = 0.1 Ω

C111 = 470 μ, 10 V

With this power supply the crowbar PE 1379/00 described in 4.10.1.1. is also used.

4.11. PW1500/05, PW1500/06, PW1500/15 AND PW1500/16.

4.11.1. General

The circuits to control the operation of the sample loader or the sample changer are on circuit boards, as follows:

A11 — Changer control — mounted in the spectrometer.

A1 — Microswitch buffer.

A2 — Motor drive.

A3 — Optical reader.

A5 — Reference tray drive (PW1505 only).

The lay-out of the components on the circuit boards is shown in the spare parts listing in paragraph 8.5.2. and 8.5.3.

In addition to the above mentioned circuits, there are various microswitches and a light-beam circuit fitted to the loader or the changer, and a light-beam detector circuit in the spectrometer loading position. The output from the spectrometer detector circuit goes to the microprocessor via the spectrometer control 3 circuits.

The circuit diagrams described are functional, and are as follows:

		PW1500	/0·	/1·
Control circuit	—	Figure	4.11.3.1.	4.11.3.2.
Sample and tray transport	—	Figure	4.11.3.3.	4.11.3.4.
Motor drive	—	Figure	4.11.3.5.	4.11.3.6.
Optical reader	—	Figure	4.11.3.10.	4.11.3.10.

. = 5 = 50Hz version
. = 6 = 60Hz version

Wiring diagram

A wiring diagram of the PW1500/0. sample loader, with the reference tray option, is shown in figure 4.11.1.1., and figure 4.11.1.2. shows the wiring scheme of the PW1500/1. sample changer.

Block diagram

A block diagram of the PW1500/1· sample changer circuit is shown in figure 4.11.1.3., and this diagram can also be used for the PW1500/0· sample loader.

The diagram shows that the microprocessor software enables various functions on the changer via the module and byte address lines. Thus, single functions can be checked as described in paragraph 7.6.

The input/output write and read lines enable the instruction to be passed to the changer motors, or the status of the motors, microswitches, sample detectors and optical reader to be read.

Error and stop signals can be generated if various operations are not completed within determined times, or if microswitch operation or sample detection is not correct.

The hardware circuits will self-check the selected operation, for example, if a motor operation is requested from the microprocessor the signal will also select information on the state of the microswitches from the buffer.

If a motor is running, but after a hardware preset delay an end position signal is not generated, the timer will inhibit the action.

4.11.2. List of signal mnemonics for sample loader and sample changer

The signals used between the various circuits for the sample loader and for the sample changer are listed below, in alphabetical order.

ADRB 0 to 3	Address byte selection bit 0 to 3
ADRM 0 to 3	Address module selection bit 0 to 3
ASCB 1 to 8	Automatic sample changer data byte bit 1 to 8
ASCCP	Automatic sample changer control present
ASCON	Automatic sample changer on
B1SLT	Busy motor 1 shift left, spectrometer side
B1SRT	Busy motor 1 shift right, spectrometer side
B4HLD	Busy motor 4 horizontal load action
B4HMO	Busy motor 4 horizontal movement
B4HUL	Busy motor 4 horizontal unload action
BBUCB	Byte busy circuit bit (0010)
BGRBB	Byte grab position buffer
BTRAB	Byte tray position buffer
BORPB	Byte optical reader program number buffer
BORTB	Byte optical reader tray identification buffer
BUSSY	Busy system signal
BUSYL	Busy line signal
CLEAR	Clear signal from the microprocessor
EGRBB	Enable grab position buffer
EORPB	Enable optical reader program number buffer
EORTB	Enable optical reader tray number buffer
ETRAB	Enable tray position buffer
GM4HL	Grab motor 4 horizontal load
GM4HU	Grab motor 4 horizontal unload
GM5VT	Grab motor 5 vertical movement
INSTC	Inhibit stop condition
IO BU 0 to 7	Input/output data bus bit 0 to 7
IORED	Input/output bus read signal
IOWRT	Input/output bus write signal
LORON	Lamps (LED) optical reader on
MONTB	Monitor tray busy
MTMLP	Monitor tray move to loading position
MTMRP	Monitor tray move to rest position
RBSM 1 to 5	Reset busy signal of motor 1 to 5
REDMO	Read module signals
RTGOR	Read tray transport, grab or optical reader signals
SCCAD	Sample changer control address
SPG4H	Stop grab motor 4 horizontal movement
SPG4V	Stop grab motor 4 vertical movement
SPT1S	Stop transport motor 1 at spectrometer side
SPT2F	Stop transport motor 2 at front side
SPT3Q	Stop transport motor 3 for queueing trays
STRGM	Start grab movement
STRML	Start monitor tray movement to loading position
STRMR	Start monitor tray movement to rest position
STRTP	Start tray transport movement
TIME 1	Time output of error delay 1
TIME 2	Time output of error delay 2
TM1SL	Tray transport motor 1 shift left at spectrometer side
TM1SR	Tray transport motor 1 shift right at spectrometer side
TM2FL	Tray transport motor 2 at front side shift left
TM3QU	Tray transport motor 3 queue trays

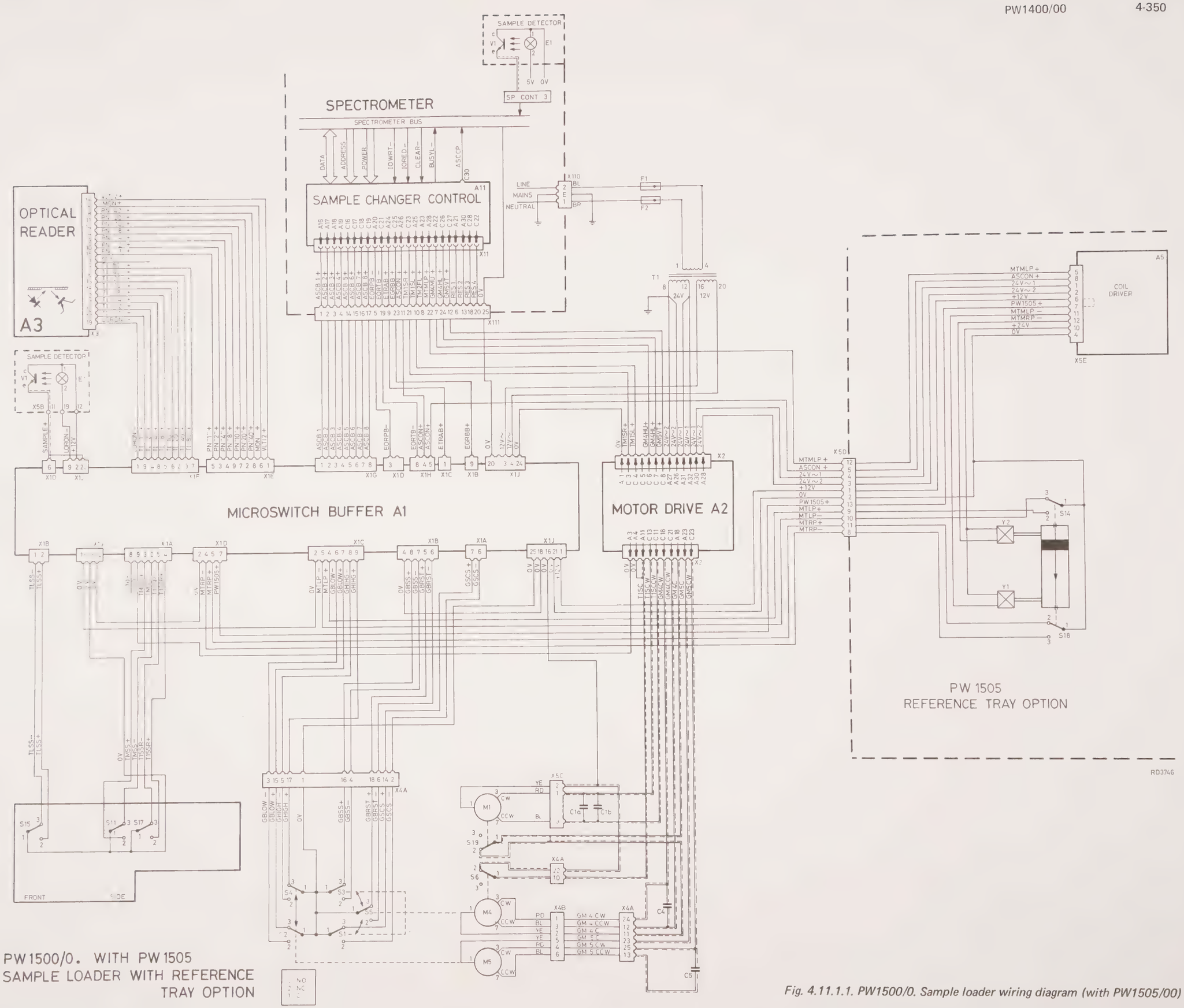


Fig. 4.11.1.1. PW1500/0. Sample loader wiring diagram (with PW1505/00)

PW1500/1.
SAMPLE CHANGER 72 POS.

Fig. 4.11.1.2. PW1500/1. Sample changer wiring diagram

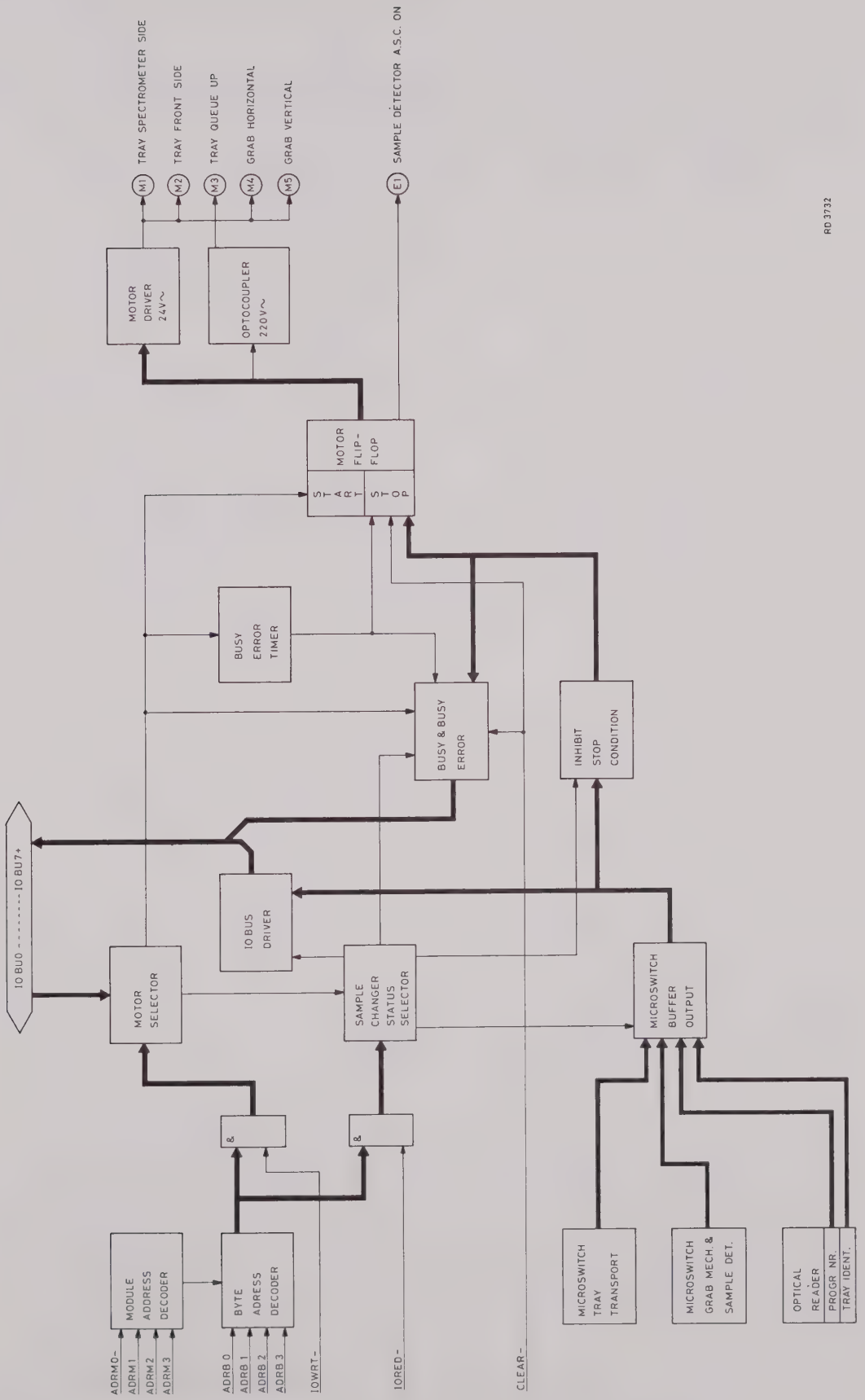


Fig. 4.11.1.3. PW1500/1. Block diagram

4.11.3. Control circuit

The control circuit pcb is fitted in position 11 of the spectrometer right-hand electronics rack. The circuit board can be used with either the sample loader or with the sample changer, and selection is made on the jumpers of the circuit board, as shown in table 3.21.2.1.

The control circuit, with jumper selection for the loader, is shown in figure 4.11.3.1. and in figure 4.11.3.2. for the sample changer.

Module selection

When the loader or changer is installed it can be addressed from the microprocessor by the module address lines, as follows:

Line =	ADRM3–	ADRM2–	ADRM1–	ADRM0–	Coded value
Level =	0	1	1	1	/8

Thus, the output SSCAD– (sample changer control addressed) is true from the decoders B16 and the first byte address decoder is enabled.

Byte address lines

When the sample changer (or loader) is selected and signals ADRB0 and ADRB1 are low the second byte decoder (D15-12) is enabled and the level of the lines ADRB2 and ADRB3 will determine if signals BTRAB, BGRBB, BROPB or BORTB are to be output.

The byte address line outputs are shown in the following table:

SIGNAL	ADRB3– (A0)	ADRB2 (A1)	ADRB1–	ADRB0–	BYTE VALUE
BTRAB–	0	0	0	0	/F
BGRBB–	1	0	0	0	/7
BORPB–	0	1	0	0	/B
BORTB–	1	1	0	0	/3
TGORA–	state immaterial		0	0	3, 7, /B, /F
BBUCB–	0	0	(A0) 1	(A1) 0	/D

Further action is largely dependent on the state of the write and read lines (IOWRT and IORED); also the sample changer must be on (ASCON true).

Sample changer on

The signal ASCON+ is true when changer operation is selected and ready. The signal is generated from the three-state latch D39 [K/19] by the following signals:

ADRM 0 to 3	= /8
ADRB 0 to 3	= /7 (1000) = BGRBB– = 0
IOWRT	= 0 (gives start grab movement STRGM– true)
IOBU7+	= 0 i.e. D13-10 [F/15] = 1
CLEAR–	= 1 i.e. D13-4 [L/18] = 0 and D13-11 = 1
IOBU0+	= 1 i.e. D5-10 [F/15] = 0

These will give ASCON+ true, and will enable data from the "stop motors" circuits to pass to the motor flip-flop, and also stop the reset to the sample changer busy latches D3 and D4 [B,C/22].

When the loader and reference (monitor) tray option are fitted, the ASCON+ signal will also enable data to trigger the one-shot D1 [C/13].

ASCON+ is also fed to the sample and tray transport circuit (figure 4.11.3.3. and 4.11.3.4. [C/4]) to switch on the sample detector lamp E1, and also the optical reader.

Sample changer off

The sample changer is switched off when ASCON+ = 0, which happens by CLEAR– = 0, or by the following combination from the microprocessor:

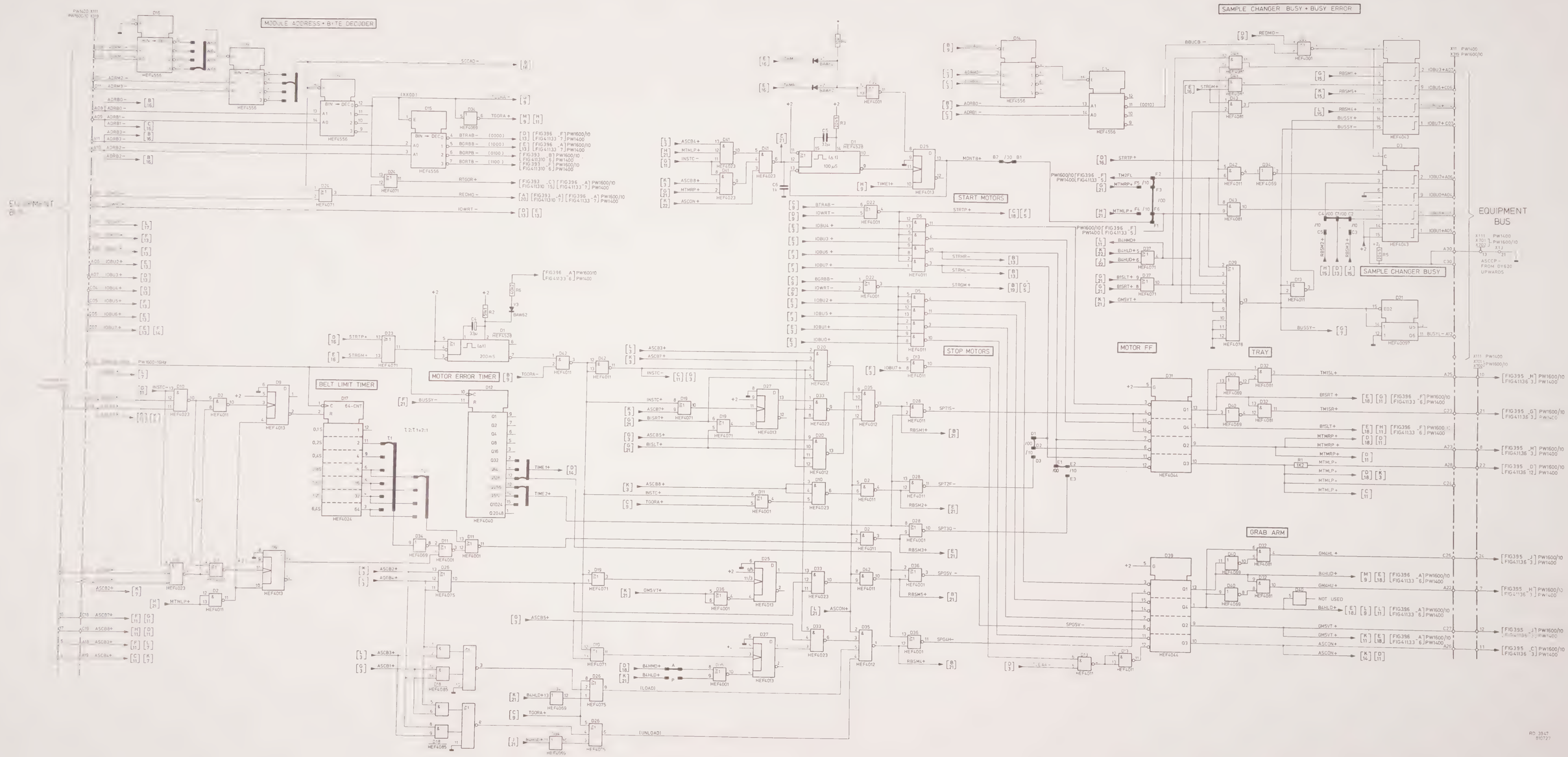


Fig. 4.11.3.1. PW1500/0. Sample changer control circuit diagram

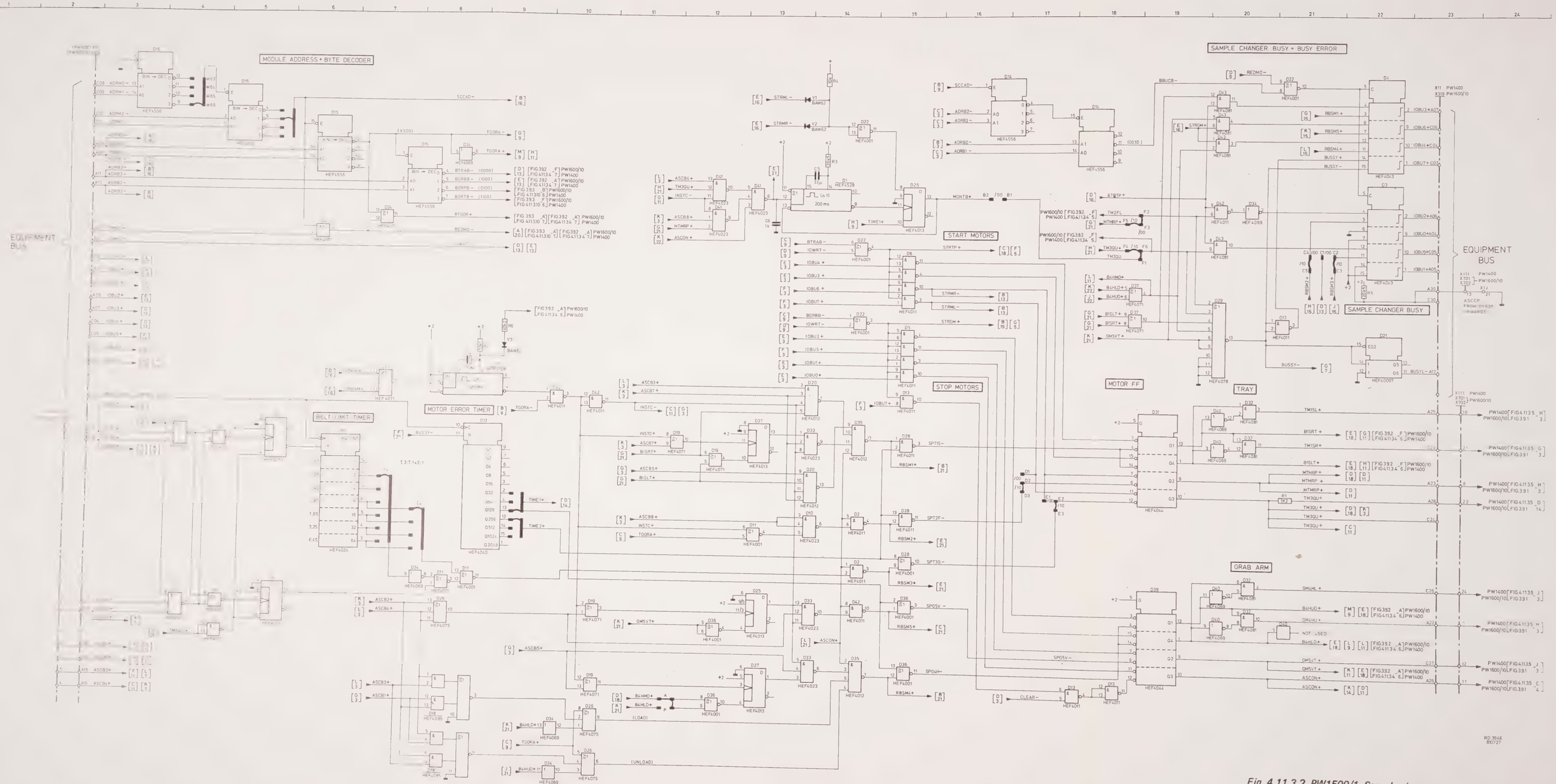


Fig. 4.11.3.2. PW1500/1. Sample changer control circuit diagram

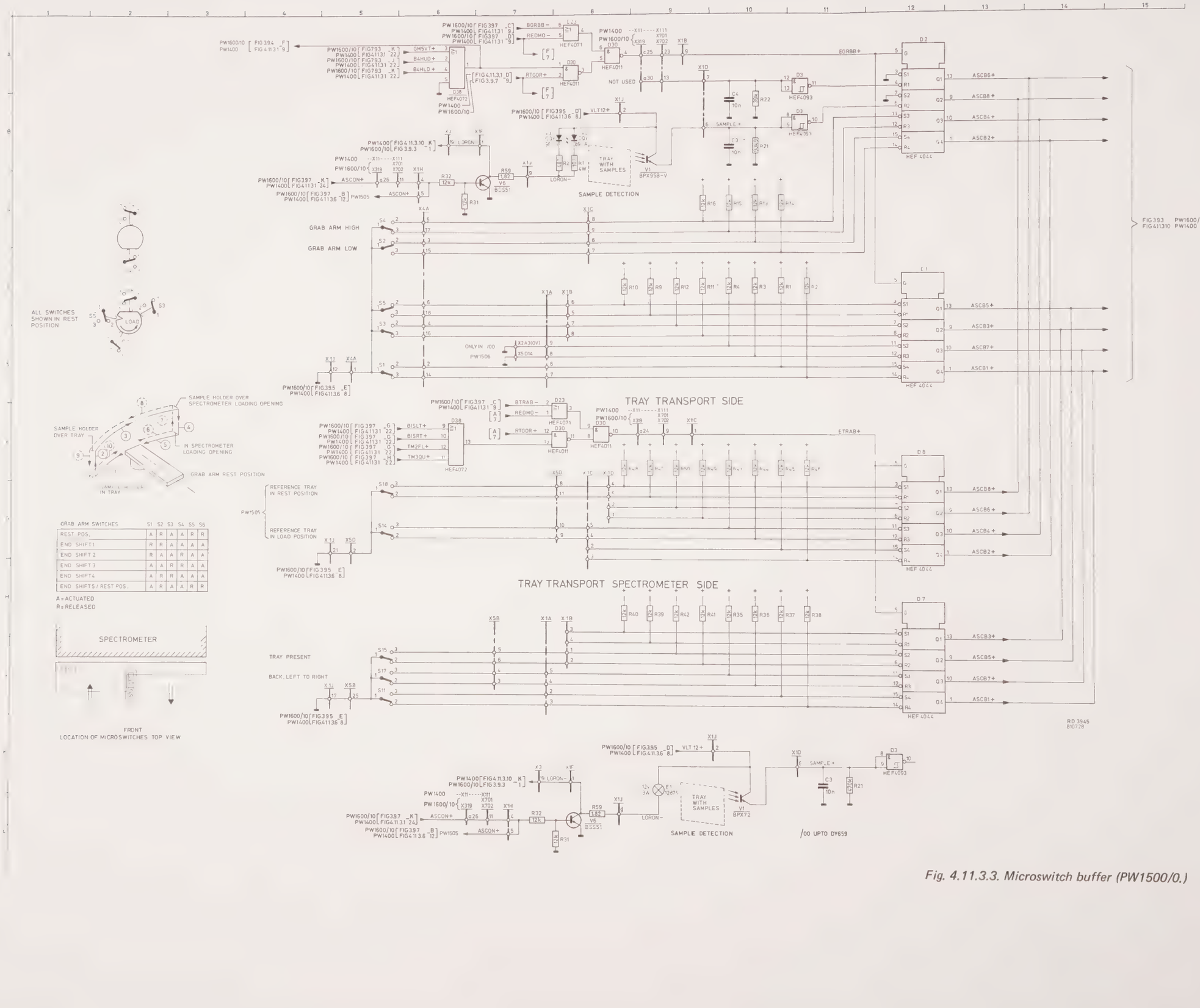

SAMPLE DETECTION
GRAB ARM HIGH
GRAB ARM LOW
ALL SWITCHES SHOWN IN REST POSITION
LOAD
SAMPLE HOLDER OVER SPECTROMETER LOADING OPENING
SAMPLE HOLDER OVER TRAY
IN SPECTROMETER LOADING OPENING
GRAB ARM REST POSITION
IN TRAY
GRAB ARM SWITCHES
S1 S2 S3 S4 S5 S6
REST POS. A R A A R R
END SHIFT 1 R R A A A A
END SHIFT 2 R A A R A A
END SHIFT 3 A A R R A A
END SHIFT 4 A R R A A A
END SHIFT 5 / REST POS. A R A A R R
A = ACTUATED
R = RELEASED
SPECTROMETER
FRONT
LOCATION OF MICROSWITCHES TOP VIEW
TRAY TRANSPORT SIDE
REFERENCE TRAY IN REST POSITION
REFERENCE TRAY IN LOAD POSITION
TRAY TRANSPORT SPECTROMETER SIDE
TRAY PRESENT
BACK, LEFT TO RIGHT
TRAY WITH SAMPLES
/00 UPTO DY659
RD 3945 810728

Fig. 4.11.3.3. Microswitch buffer (PW1500/0.)

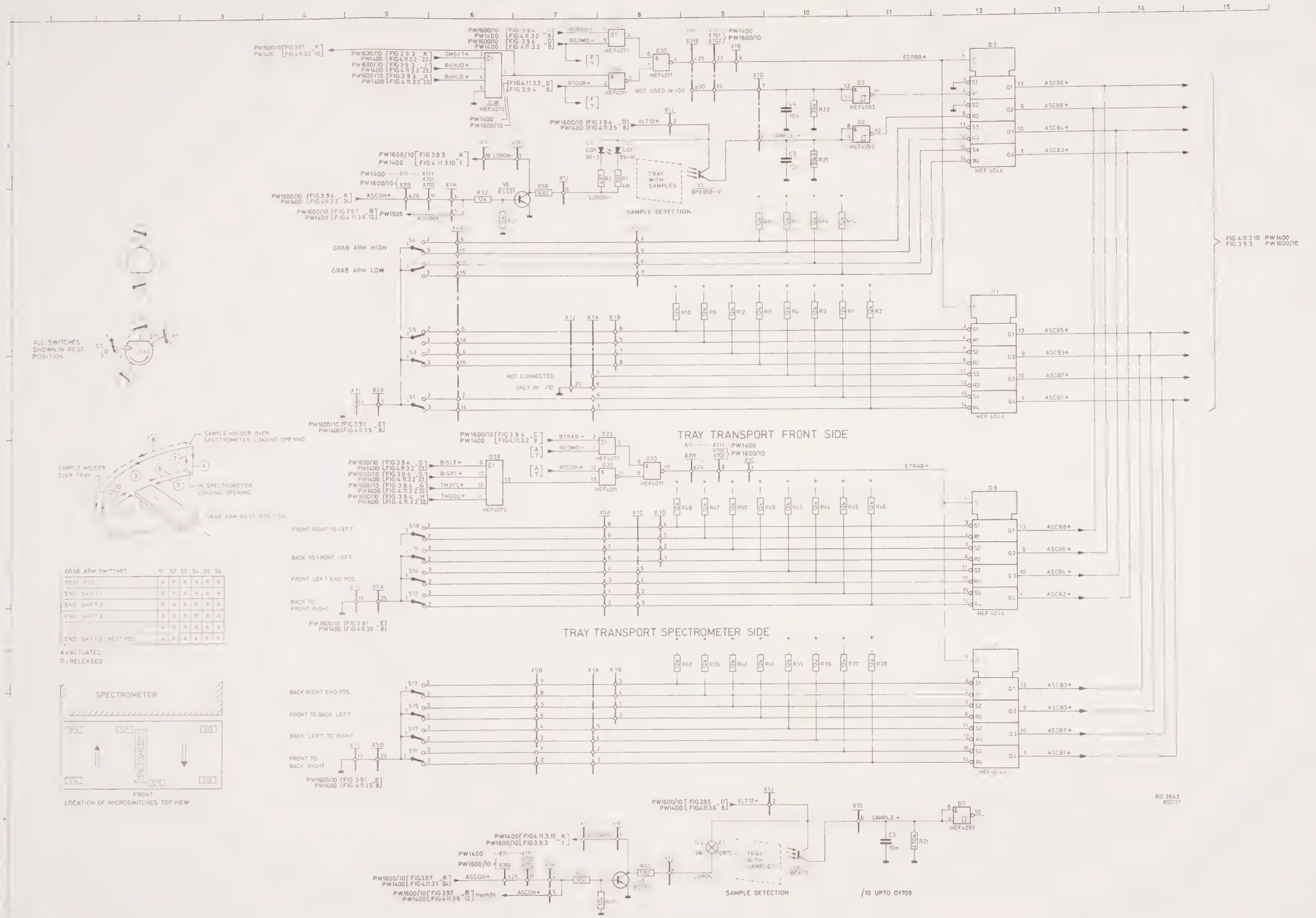


Fig. 4.11.3.4. Microswitch buffer (PW1500/1.)

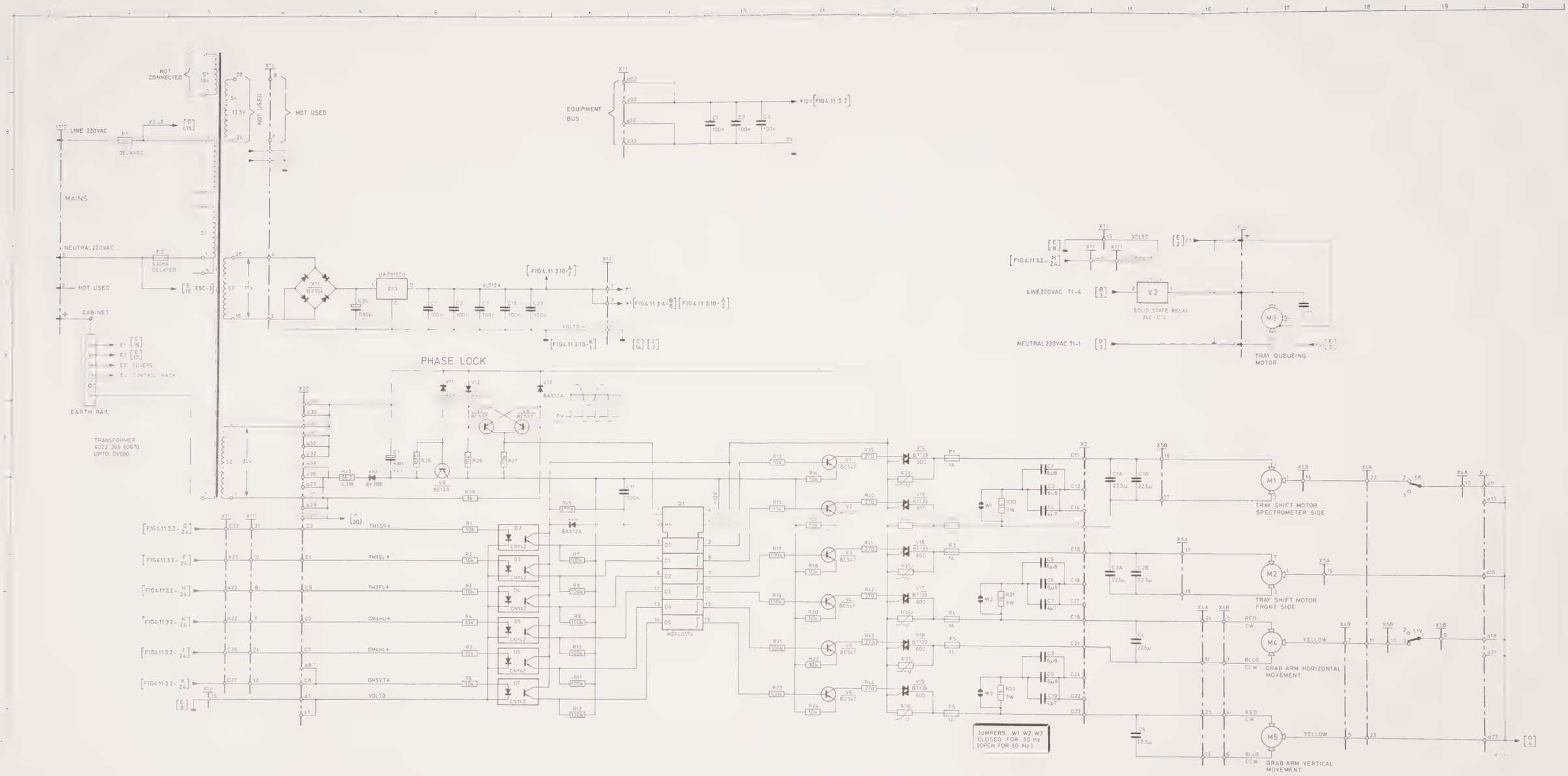


Fig. 4.11.3.5. PW1500/1. Motor drive circuit

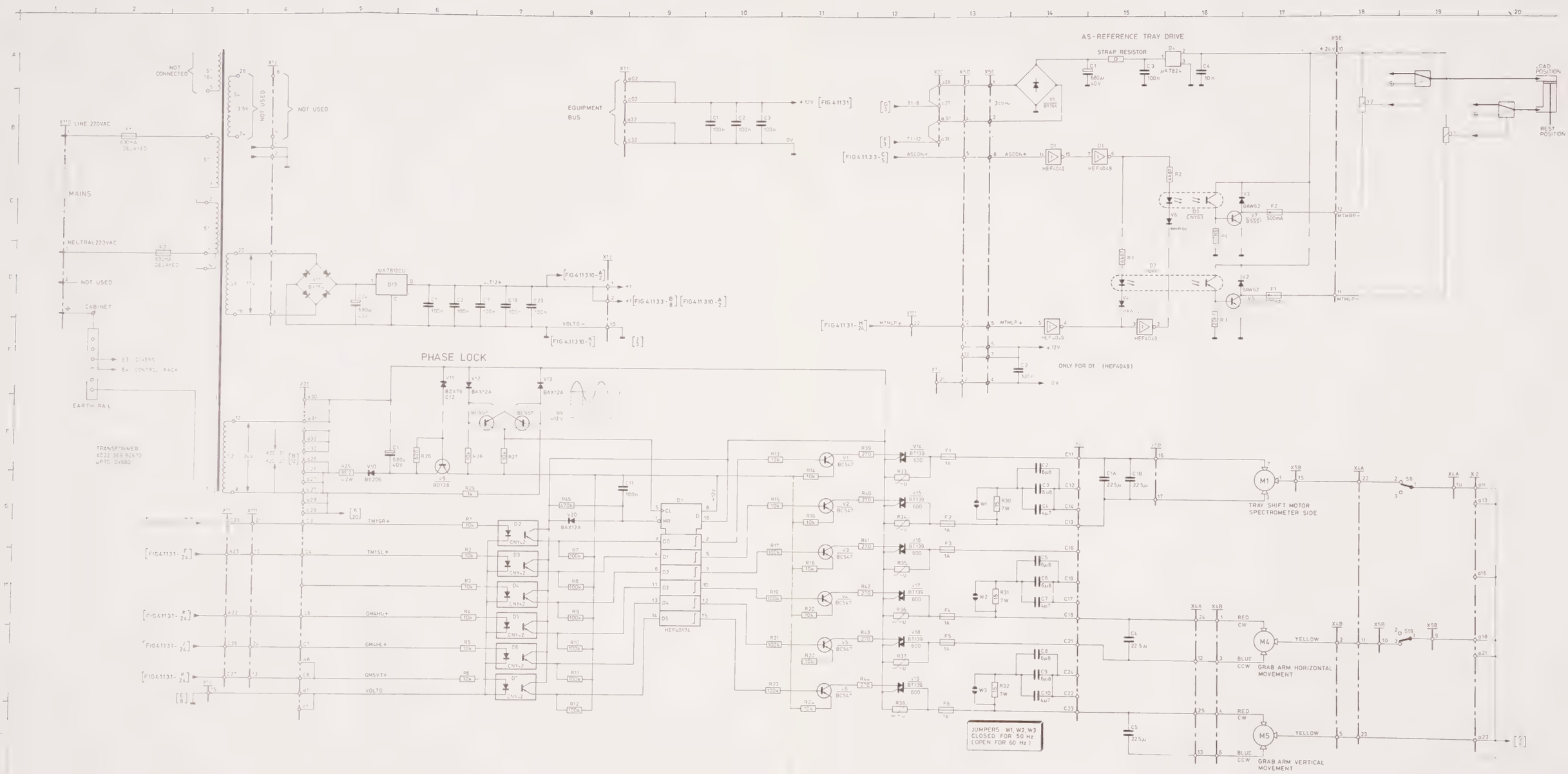


Fig. 4.11.3.6. PW1500/0. Motor drive circuit

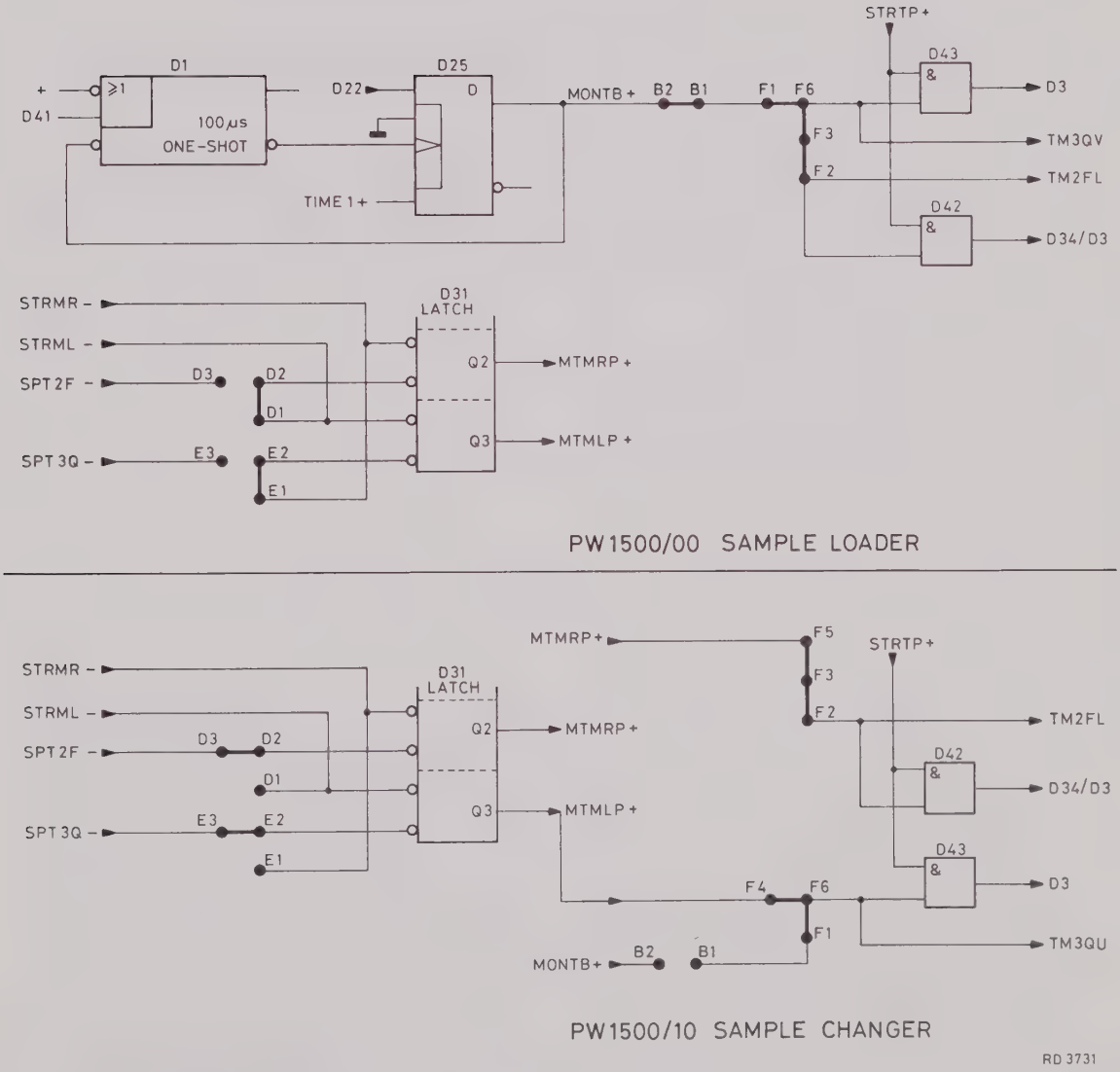


Fig. 4.11.3.7. Jumper connections for tray transport

ADRM0 to 3 = /8
IOWRT– = 0
BGRBB– = 0
Figure IOBU7+ = 1

4.11.3.1. In either of the above states is input the data on the NAND gates D2/D35 and D42 are blocked to the stop motor circuits. Also the reset busy motor signals RBSMx+ are now true to the IOBU1 to 7 lines to the equipment bus. This results in the motor flip-flops D31 and D39 being reset and all motors being stopped.

As soon as the motor error time (D12 [F/8]) has elapsed, the motor flip-flop circuit is reset, which then resets the busy line and BUSYL– = 0 to the equipment bus.

Input/output read

4.11.3.1. The microprocessor generated signal IORED causes the read module signal REDMO– to be true [D/6], when the sample changer module is chosen (ADRM0 to 3 = /8).

The microprocessor selected byte signals ADRB2 and 3 will select signals BTRAB–, BGRBB–, BORPB– or BOTRB– from D15 [C/8], and the signal is gated with REDMO– [fig. 4.11.3.3. and 4.11.3.4., A/8, F/8] to select the output of data on the ASCB1 to 7 lines from the optical reader, the tray transport and grab arm microswitches, and the sample detection circuit. The read transport, grab or optical reader signal RTGOR– must also be true to enable the output of the ASCB line data to the equipment bus.

Thus, the microprocessor can read the status of the sample changer (or loader).

Input/output write

When the IOWRT– signal is low (IORED– not true) a sample changer movement is initiated, dependent on the state of the byte address lines.

If the ADRBx input generates BTRAB–, then D22 [D/14] allows the start tray transport signal (STRTP+) to be true, enabling the NAND gates D6 for the bus lines IOBU3,4, 6 and 7.

If ADRBx generates BGRBB–, then D22 [E/14] allows the start grab movement signal (STRGM+) to be true, enabling the NAND gates D5 and D13 for the bus lines IOBU0, 1, 2, 5 and 7.

Thus, the microprocessor initiates the operation of the tray and grab arm movement.

Tray movement

4.11.3.1. As previously stated, the IOWRT– and BTRAB– signals true produce the start tray movement signal STRTP+, which enables gates D42 [C/20] and D43 [B, D/20] to pass motor busy signals to the microprocessor. The STRTP+ signal also enables the gates D6 [D, E/15]to pass IOBU3, 4, 6 and 7 data to the tray motor latch D31 [G/19].

These signals are passed to the motor drive circuit (figure 4.11.3.5. or 4.11.3.6.).
Note that the above routing of signals will depend on the jumper settings for the sample loader (PW1500/·) or the sample changer (/1·), see figure 4.11.3.7.

4.11.3.1. The outputs from D31-13 and 1 go to a flip-flop circuit (D32, D40) which will select only one direction of movement of the tray shift motor at the spectrometer side, i.e. shift-left or shift to the right.

PW1500/1· Queueing motor M3

4.11.3.1. The queueing motor operation is selected when the module address is /8, the byte address is /F i.e. signal BTRAB– is true, and the write signal IOWRT– is true. This enables IOBU3, 4, 6 and 7 via gate D22 [fig. 4.11.3.1. or 4.11.3.2., D/14] .

If the microprocessor outputs IOBU7+ = 1 the latch D31 will be set so that TM3QU+ is true, and the solid-state relay V2 (figure 4.11.3.5. [D/15]) will switch on the queueing motor M3. The signal MTMLP also goes to D43
4.11.3.2. [D/19] and if the start tray transport signal STRTP+ is true the busy error buffer D3 [D/22] is set, and IOBU5 = 1.

Signal TM3QU+ is also input to D29 [E/19] and the gate output BUSSY– will enable the buffer D21 [E/22] so signal BUSYL– is true to the microprocessor.

The BUSSY– signal also goes to D4 [B/22], and outputs as IOBU7+ = 1; also, the motor error timer D12 [G/8] is enabled.

Figure 4.11.3.2. An **immediate stop** of the M3 motor occurs if the ASCON+ signal is not true (= 0) to gate D2 [J/14], producing the reset signal RBSM3+ to D28 (SPT3Q–) and D31 [G/19] to reset signal TM3QU+ (=0). The busy error buffer circuit D3 [D/22] is reset by RBSM3+ to make IOBU5+ = to signal a fault condition to the microprocessor

4.11.3.2. A **stop without reset** of the busy error circuit buffer will occur when the motor error timer D12 [H/8] reaches the TIME2+ output, to give the stop motor signal SPT3Q via D28 [J/15]. This ensures that the motor drive is switched off if a tray does not reach an end stop by a pre-determined time T2. This time is normally set to about 1.5 times the time for a tray to move the full depth of the platform.

4.11.3.2. When the motor has stopped, the motor signal will remove the BUSYL– signal (= 1), but the buffer D3-10 [D/22] signal is not reset as signal RBSM3+ is not generated. Now the microprocessor detects an error condition and takes action accordingly.

4.11.3.4. A **stop from the microswitch actions** is derived from S11/S15 or S12/S16, see figure 4.11.3.4. This information comes via the latches D7 and D8 (figure 4.11.3.4.) which are enabled by the TM3QU (MTMLP+) = 1 signal as the motor M3 is still running. The information on switches S11, S12, S15 or S16 is output on the ASCB1, 2, 5 and 6 lines.

4.11.3.2. ASCB1+ and ASCB5+ go to gate D10 [G/4] and when both are high (S11 and S15 operated), the D flip-flop D9 [G/5] is triggered to reset the belt limit timer D17. The tray queueing motor M3 will stop after the set delay time $\tau 2$, via D34-8, D11-3 and D11-11 [J/8].
This delay allows a tray to be correctly positioned on the platform before the shift (sideways) movement of the tray.
The setting of the time ratios from D17 should be such that $\tau 1 : \tau 2$ is $1 \geqslant 2$. The signal BUSSY+ will trigger the one-shot D1 [F/8] to block any stop conditions except ASCON+ = 0.

4.11.3.4. Hardware protection of the operation of motor M3 is ensured by the signal TM3QU+ [D/18] which enables the latches D7 and D8 (figure 4.11.3.4. [H/12]) via D38-13, D30-11 and D30-10 whenever the microprocessor is not controlling the operation via BTRAB– and REDMO–.
Therefore, the hardware constantly monitors the end position microswitches during tray movement.

PW1505/00 Reference tray option

4.11.3.1. The sample loader operation differs from the changer as there is no tray queueing and the motor M3 is not fitted. The only tray loading movement is when the reference tray option is fitted. The changer control circuit jumpers are now arranged as table 3.21.2.1. and figure 4.11.3.7.; and the signals MTMRP+ and MTMLP+ from the latch D31 are used, see figure 4.11.3.1. [G/19].

4.11.3.1. The busy signals are derived in a similar way to those for the sample changer, via gates D6-10 and 3 [E/15] when signal STRTP+ = 1. The output signals from D6 (STRML– = 1 and STRMR– = 1) are OR gated at D22 [B/14]. The high output sets the busy flip-flop D25, which outputs the monitor tray busy signal MONTB+. This sets the latches D3 [D/22] via gates D42 and D43, to output signals IOBU2 and 5 to the microprocessor.

Reset is derived from the microswitch S14 if the signal MTMLP+ = 1, or from S18 if the signal MTMLR+ = 1. The one-shot D1 [C/13] is triggered, via the gates D41, to reset the busy flip-flop D25 after 100 μs. This then resets the busy bits from D3.

4.11.3.6. Note that the signals MTMRP+ and MTMLP+ do not change their state until the microprocessor signals are changed. Therefor the signal ASCON+ will **not** reset the signals to the valve control (fig. 4.11.3.6.).

If the signal MTMLP+ = 1, the opto-coupler D2 (figure 4.11.3.6. [D/15] causes the V5 transistor to bottom, and the valve Y1 is energised to cause the reference tray to be moved to the loading position. If MTMLP+ = 0 the valve Y2 is operated to move the tray to the rest position in the PW1505.

Grab arm movement

4.11.3.1. In a similar manner the byte address signal BGRBB– and IOWRT– will generate the start grab arm movement signal STRGM+ from D22 [E/14].

4.11.3.1. This will signal the microprocessor if either of the grab arm motors (M4 and M5) are busy, via D43 [B/19] and D4 to the equipment bus.

The STRGM+ signal will also enable the gates D5 and D13 [E, F/15] to pass the IOBU0, 1, 2, 5 and 7 data to the grab motor latch D39 [K/18]. These signals are then passed to the motor drive circuit (figures 4.11.3.5. and 4.11.3.6.).

Note that the grab arm control circuit is not changed for use with the loader or the changer, therefore, there are no jumper settings in the circuit.

Figure 4.11.3.1. The first step of the grab arm (step 1 of figure 4.11.2.8.) is made when the microprocessor inputs IOBU5 = 1 and IOBU2 = 0. Via D5 and D39 the signal B4HLD+ = 1 is generated and B4HUD is reset (= 0). The flip-flop formed by D40 and D32 ensures that the motor M4 can only rotate in one direction.

Signal B4HLD+ sets the changer busy buffer D4-10 [B/22], via gates D37-4 [E/19] and D43-3 [B/20], as the start grab motor signal STGRM+ is true (IOWRT– = 0 and BGRBB– = 0 to D22). Motor M4 will start running.

The system busy signal BUSSY+ triggers the one-shot D1 [F/8], which will inhibit any stop conditions from the microswitches via INSTC.

4.11.3.4. The signal B4HLD+ = 1 to gate D38 (figure 4.11.3.4. [A/6]) enables the latch D2 to connect the grab arm microswitch (S1 to S5) conditions to the ASCB lines, and hence to the equipment bus to the microprocessor.

4.11.3.1. Step 1 will continue until switch S1 is released (S2 is also released), so that signals ASCB1+ = 1 and ASCB2+ = 1. With B4HLD+ they go to gate D26 [L/10] to reset the latch D39 [K/19] via gate D35-1 [L/15] and D36-11. The output signal RBSM4+ from D35-1 resets the busy buffer D4 [B/21] to change IOBU4 to the microprocessor.

This will initiate step 2, and now the signal GM5VT+ = 1, via IOBU1+ = 1, see figure 4.11.3.9. The vertical motor

4.11.3.9. M5 will operate, and when switches S2 and S4 change over, the step is completed and the motor drive stops.

The microprocessor starts another horizontal movement (step 3) but now the motor stop conditions occur when S3 releases (S4 showing grab arm high). The motor M4 will now stop with the grab over the spectrometer loading hole.

Step 4 is similar to step 2, and step 5 is similar to step 1 to bring the grab arm to the rest position. The signal ASCB5+ = 1 stops the grab arm operation.

The motor error timer operates in a similar manner to the tray transport operation, to stop motor M4 and/or M5 if TIME1+ = 1. TIME1+ is true after 12.8 s from the start of the operation. The signal ASCON+ = 0 will stop the motor operation.

The grab arm operation is common to the sample loader PW1500/00, and to the changer PW1500/10.

Optical reader

4.11.3.1. The byte address signals can output BORPB– or BORTB– from D15 [C/8], and these signals (with REDMO–)

4.11.3.10. go to the optical reader circuit figure 4.11.3.10. The signals will enable data from the code card on the sample tray to be passed to the microprocessor, either the measuring program number (BORPB– true) or the sample tray number (BORTB– true).

Sample changer busy

4.11.3.1. The state of the sample changer busy lines will be passed to the microprocessor when the read signal (REDMO–) is true. When the byte address lines (ADRB) are 0010 (/D), the output from decoder D14-11 [B/18] will enable the latches D4 and D3 [B,C/22]. This ensures that any changer errors are signalled to the microprocessor via the IOBU0 to 7 lines.

The system busy signal BUSSY– is generated from D29 [E/20] when one or more of the inputs is high, i.e. the following signals are true:

MTMRP+	(Monitor tray move to rest position)	Inputs D29 [E/20]
MTMLP+	(Monitor tray move to load position)	
B1SLT+	(Busy motor 1 spectrometer side shift left)	
B1SRT+	(Busy motor 1 spectrometer side shift right)	
B4HLD+	(Busy motor 4 horizontal move loading)	
B4HUD+	(Busy motor 4 horizontal move unloading)	
GM5CT+	(Grab motor 5 vertical movement)	

The BUSSY– signal will generate BUSYL– to the equipment bus, and will also release the motor error timer D12 [G/8].

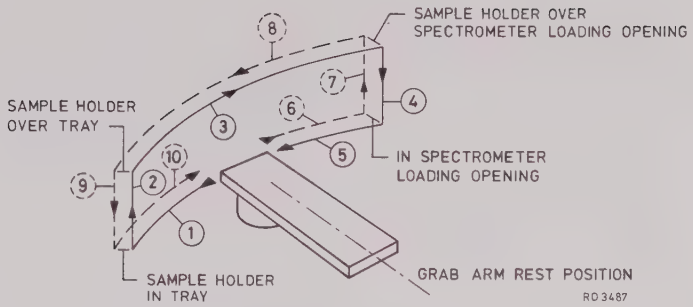


Fig. 4.11.3.8 Grab arm operating cycle

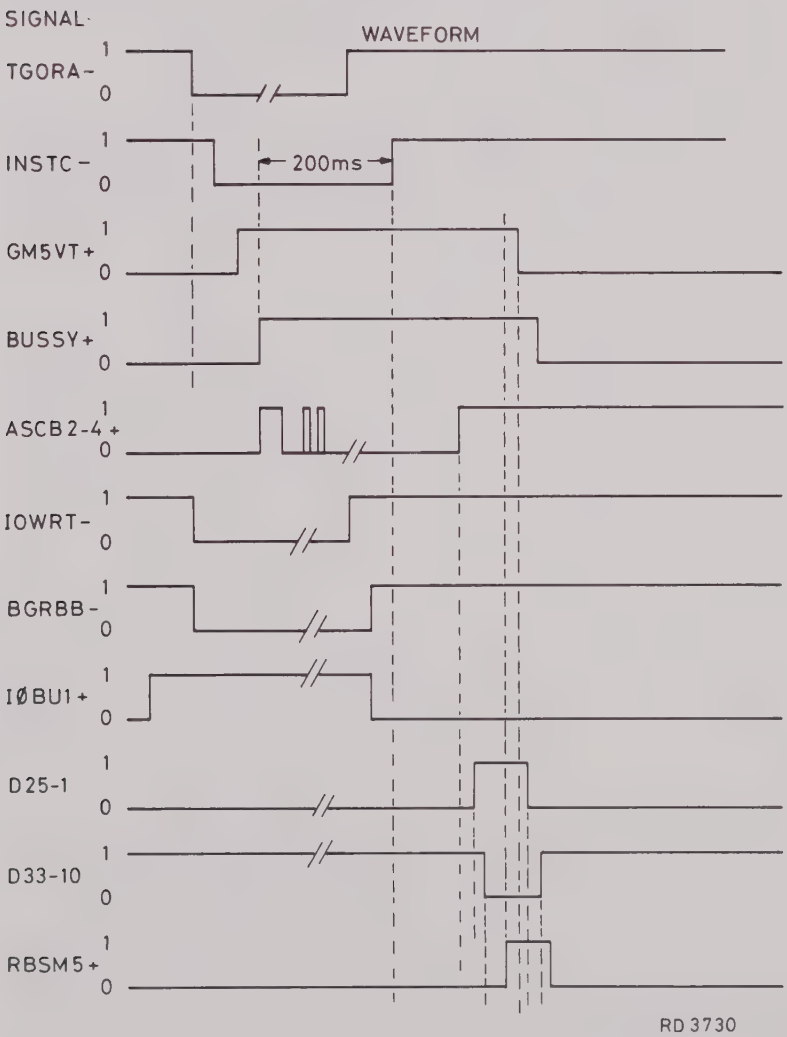


Fig. 4.11.3.9 Grab arm vertical step timing diagram

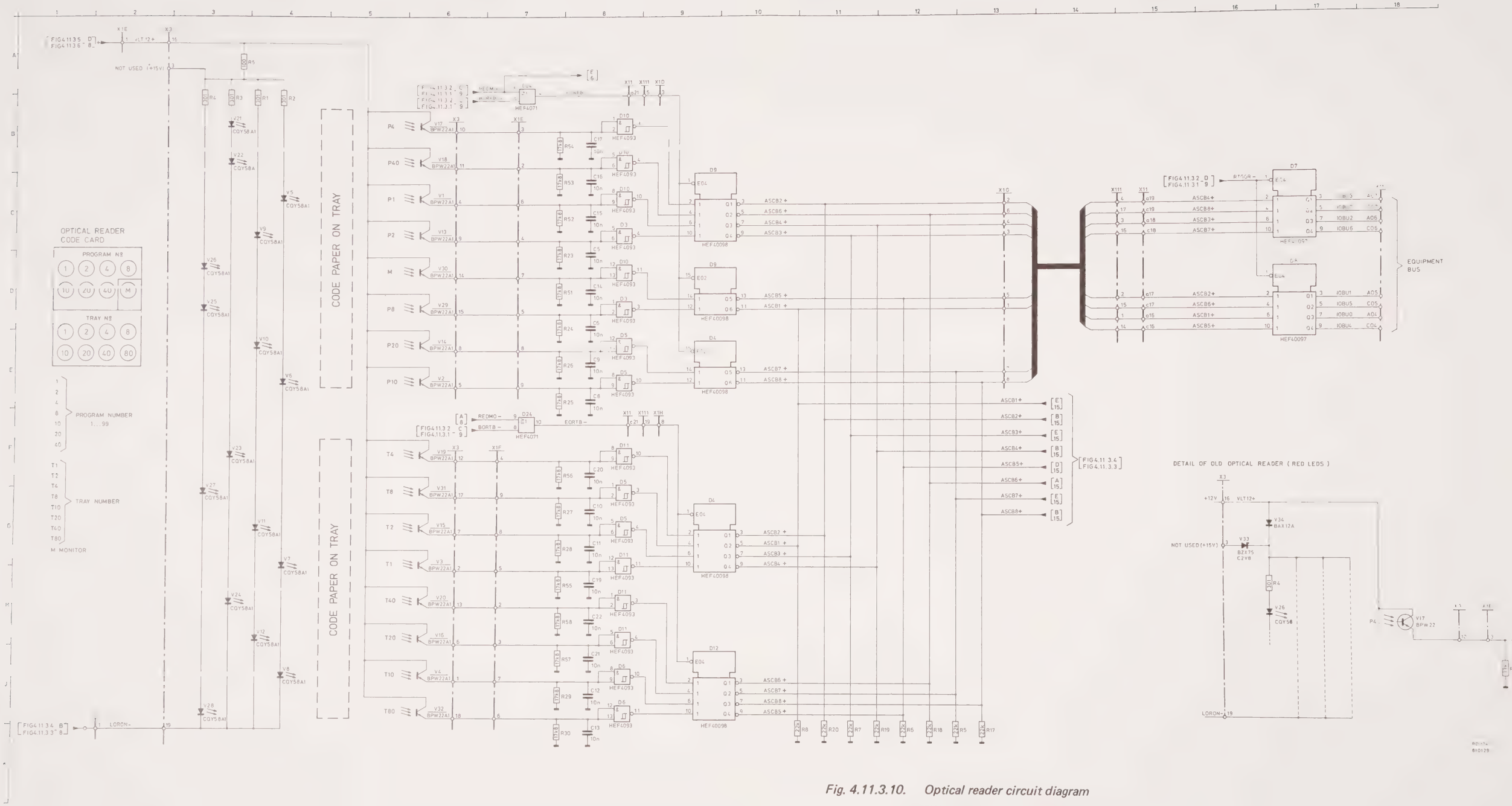


Fig. 4.11.3.10. *Optical reader circuit diagram*

PW 1500/0· from DY640
PW 1500/1· from DY680
New optical reader (Dark blue Leds)

4.11.4. Sample and tray transport

Figure 4.11.3.4. 4.11.3.10

The main circuit is shown in figure 4.11.3.4. (PW1500/1· or figure 4.11.3.3. (PW1500/0·) and generates the automatic sample changer data byte signals ASCB1 to 8, to the equipment bus. These signals can also be generated from the optical reader, see figure 4.11.3.10. The format of the signals is derived from the position of the tray transport microswitches, the grab arm microswitches, and the sample detection circuit.

Tray transport

4.11.3.4.

The situation of the microswitches on the tray transport platform will be passed through the latches D7 and D8 [C,D/17] when ETRAB+ is true, For ETRAB to be high the BTRAB– (address bytes = 0000) and read module REDMO– signals must be true, and D30-11 must be low. If all the B1SLT+, B1SRT+, TM2FL+ and TM3QU + inputs to D38 [F/6] are not true (low), and the read signal RTGOR+ is true, then D30-11 is high and the tray microswitch data is inhibited from passing to the equipment bus.

The control of the tray transport motor drive signals is described in paragraph 4.11.3., and the motor drive in paragraph 4.11.5.

Grab arm

4.11.3.4.

In a similar way the grab arm microswitch information is passed through the latches D1 and D2 when signal EGRBB+ is true. For EGRBB+ to be high the BGRBB– (address bytes = 1000) and read module REDMO– signals must be true, and D30-3 must be low. D30-3 is high when the read signal RTGOR+ is true, and the grab motors signals GM5VT+, B4HUD and B4HLD+ are not true, which inhibits the microswitch data to the equipment bus.

Sample detection circuit

4.11.3.4.

When the sample changer is switched on (ASCON+ true), the transistor V6 will conduct and the lamp E1 will light. The lamp is situated at the spectrometer side of the sample changer and the beam to the detector V1 will be interrupted when a tray with a sample holder is in position to be loaded in the spectrometer. The signal from V1 is high if a sample is not detected.

The signal from the NAND Schmitt trigger D3 will be passed to the equipment bus when the EGRBB+ (see above) is true.

4.11.5. Motor drive

The motor drive and power supply circuits are shown in figure 4.11.3.5. (PW1500/1·) and figure 4.11.3.6. (PW1500/0·).
Note that figure 4.11.3.6. shows the circuit arrangement for the PW1505/00 Reference tray option, in place of the queueing motor circuit shown in figure 4.11.3.5.

Phase lock

4.11.3.6.

The phase lock circuit is employed to ensure that the trigger pulses to the motor drive triacs (V14–K9) occur when the 24 volt a.c. supply is passing through zero.
This happens when a positive or negative half-cycle of the a.c. supply causes either V7 or V8 to conduct, and a clock pulse every half cycle goes to the D-type flip-flop D1.

Motor drive

Figure 4.11.3.6. The motor drive signals are selected by the sample changer control circuit (see paragraph 4.11.3.), and come to the D-type flip-flop D1 via the photo-couplers D2 to D7. The phase-locked clock pulse to D1-5 allows the motor drive signals to be passed to trigger the triacs V14 to V19. The triacs will drive the motors, as selected by the control circuit.

Note that the tray shift motor M1 can only operate if the grab arm is at rest (S6 normal), and the grab arm motor M4 can only operate if the tray shift (spectrometer side) is at rest (S19 normal).

Reference tray drive

When the sample loader is fitted with a PW1505 Reference tray option, the movement of a tray is by means of an air piston actuator.

4.11.3.6. When the signal ASCON+ is true, the magnetic valve Y1 is actuated if the signal MTMLP+ is true from the control circuit. If the signal MTMLP+ is not true, the magnetic valve Y2 is actuated via the D3 photo-coupler; and the sample tray with reference samples is returned from the loading position to the rest position.

4.11.6. Optical reader

4.11.3.10. The optical reader circuit is shown in figure 4.11.3.10. When a sample tray is in the loading position the identification card information is read by the reader circuit. The card has numbered holes (1, 2, 4, 8, 10, 20, 40) which are totalled to define the measuring program number, one hole (M) to advise the microprocessor that a monitor sample is in position 1 of the tray, and eight numbered holes (1, 2, 4, 8, 10, 20, 40, 80) to define the tray identification number. When a hole is punched out the light-beam is reflected by the silvered surface to the related detector, and the output goes high, i.e. the detector conducts.

Program number

4.11.3.10. The data from the coded holes on the card will be passed, via the latches D4 and D9, to the ASCB1 to 8 lines when EORPB– is true. When the address byte lines ADRB (figure 4.11.3.1. or 4.11.3.2.) are 0100 the signal BORPB– is true, and if the read module line REDMO– is true, then EORPB– is true.

In addition, data on the ASCB lines will be read by the microprocessor if the read signal RTGOR– is true from figure 4.11.3.1. or 4.11.3.2. [C/7].

Monitor present

The monitor coded hole M is detected in the same manner as the program number.

Tray identification

4.11.3.10. The latches D4 and D12 will pass the tray identification coding to the ASCB lines if EORTB– is true. This will happen if the address byte lines are 1100 to give BORTB– true, and REDMO– is true.

4.11.7. Circuit adjustments

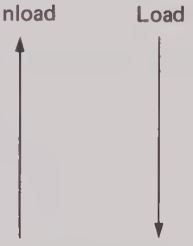
The following adjustments are described:
1. Microswitch operation by grab arm and tray movement
2. Timers in the changer control circuit
3. Light beam detection
4. Optical reader

4.11.7.1. *Microswitch operation*

The microswitches S1 to S6 are operated by the grab arm movement in accordance with the following table, also see figure 4.11.3.4. Adjust the position of the microswitches to comply with the table.

Arm position	Switch S1	S2	S3	S4	S5	S6
Rest	A	R	A	A	R	R
End shift 1	R	R	A	A	A	A
End shift 2	R	A	A	R	A	A
End shift 3	A	A	R	R	A	A
End shift 4	A	R	R	A	A	A
End shift 5	A	R	A	A	R	R

A = actuated
R = released



Start shift 6 to 10 will cause switch operation as shifts 5 to 1 above.
Arm movements as shown in figure 4.11.3.8.

The microswitches S11, S16, S17 and S19 are in the PW1500/0· Sample loader and should be adjusted to operate correctly during tray movement, see paragraph 7.6.1.1.

The PW1505/00 Reference tray option is fitted with microswitches S14 and S18, where S14 is operated when a tray is loaded, also see paragraph 3.21.4.2., and S18 is operated when a tray is in the rest position, i.e. when the tray is unloaded to the front.

The microswitches S11 to S19 of the PW1500/1· Sample changer will be operated during tray movement following the procedure in paragraph 7.6.1.1., and the state of the switches can be checked as described in paragraph 7.6.2.

4.11.7.2. *Timer operation*

The changer control circuit board, see figure 4.11.3.1. or 4.11.3.2., has a motor error timer circuit (D12) and a belt limit timer circuit (D17), and the timer outputs can be adjusted by jumper connections.
The connections are preset in the factory and will not require readjustment.

4.11.7.3. *Light beam detection*

The sample loader or changer control circuits require a signal to report the presence of a sample holder in the spectrometer loading hole, or in the tray loading position. The detection is by means of a light-beam, and the emitter (lamp) and detector should be adjusted as follows:
- Adjust the positions of the lamp bulb and the detector so that the beam is broken when a sample holder is present.
- Remove the sample and disconnect the wiring to the detector.
- Check the resistance across the detector, and adjust its position so that the resistance is less than 1.5 kΩ when the beam is not interrupted.
- Reconnect the detector.

4.11.7.4. *Optical reader*

The sixteen emitter/detector pairs used to detect the presence of a hole in the sample tray identification card are wired to the optical reader circuit board. Hole detection can be checked by following the procedure in paragraph 7.6.1.1., and the position of the emitter and/or detector can be manually re-aligned if an error is found.

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5. NONROUTINE MAINTENANCE AND ADJUSTMENTS

5.1. INTRODUCTION

This chapter provides a description of all the mechanical subassemblies, together with a description of some maintenance procedures not included in the preventive maintenance schedule. Also included are adjustment procedures for those electronic and mechanical parts requiring them.

Some of the maintenance procedures described here require the use of precision workshop facilities, special tools, or clean conditions.
These procedures should never be attempted unless the required conditions can be met, and unless the technician has the necessary mechanical skill.

Components which are mounted within the evacuated parts of the spectrometer must be kept clean to ensure minimum evacuation times and to avoid contamination of samples, collimators, analysing crystals, etc.
In particular, avoid finger marks by wearing cotton or nylon gloves. Always use clean solvents and materials for cleaning.

5.2. RADIATION PROTECTION

The castings and covers from which the spectrometer is formed provide extensive shielding against the emission of X-rays. In addition, the spectrometer is fitted in a number of places with extra shielding, usually in the form of lead sheets.

All those parts of the spectrometer which provide, shielding, either directly or indirectly, against the emission of radiation, are provided with an identification number. This number is permanently marked on the part by engraving, casting or stamping. All parts so marked have been tested and fitted according to a radiation safety guarantee scheme.

In addition all those parts which are directly important for radiation shielding, are indicated in Chapter 8 with the mark ▲

WARNING

Never file down, drill holes in, change the material of, or modify in any other way, any component which plays a part in radiation shielding.

For reasons of safety the following rules should always be followed:

1. Ensure that all spare parts used to replace numbered parts also bear identification numbers permanently applied by the manufacturer according to the radiation safety guarantee scheme.

2. Never make any modification to a part numbered according to the radiation safety guarantee scheme. In particular, do not drill any holes in or use any file or saw on, such numbered parts.

3. Never remove any numbered part from the spectrometer.

4. Never operate the spectrometer with more than 60 kV on the X-ray tube if any of the outer covers of the spectrometer is removed.

5.3. SPECTROMETER ATMOSPHERE

5.3.1. Operation

The atmosphere in the spectrometer can be either vacuum, air, or helium, selected via push buttons, on the front panel. These push buttons are mechanically interlocked so that it is not possible to make another selection until the depressed pushbutton for the current selection has been released.

This situation is shown graphically in fig. 5.3.1.1.

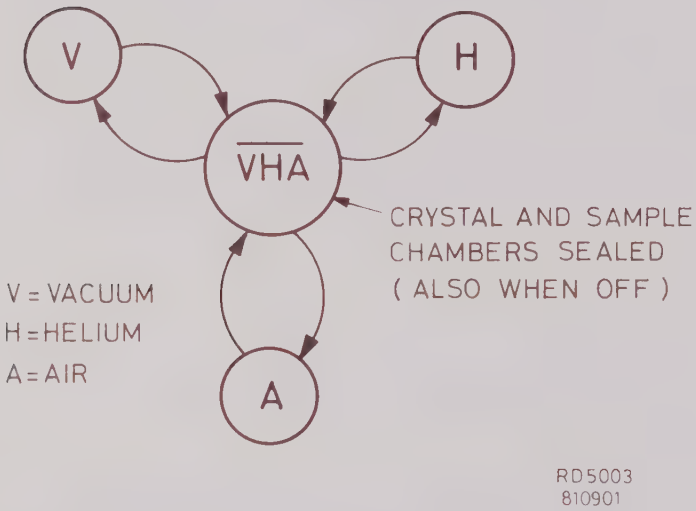


Fig. 5.3.1.1. Spectrometer atmosphere selection

With each interrupt pulse (frequency = 10 Hz) the state of the switches is checked by the microprocessor software and the latest state is stored in a RAM location.

The selection of the chosen atmosphere is shown in the flow chart fig. 5.3.1.2, while the layout of the complete atmosphere system (including the optional helium system) is shown in fig. 5.3.1.3. The layout of the basic vacuum/air system is shown in Fig. 5.3.1.4.

The upper part of the flow chart shows that:

1. If no medium is chosen ($\overline{VAH}$ = none of the pushbuttons depressed) and the spectrometer is not waiting for an operator input (C = does not appear as the last line of the output), the message "**ERROR MEDIUM" will be output.

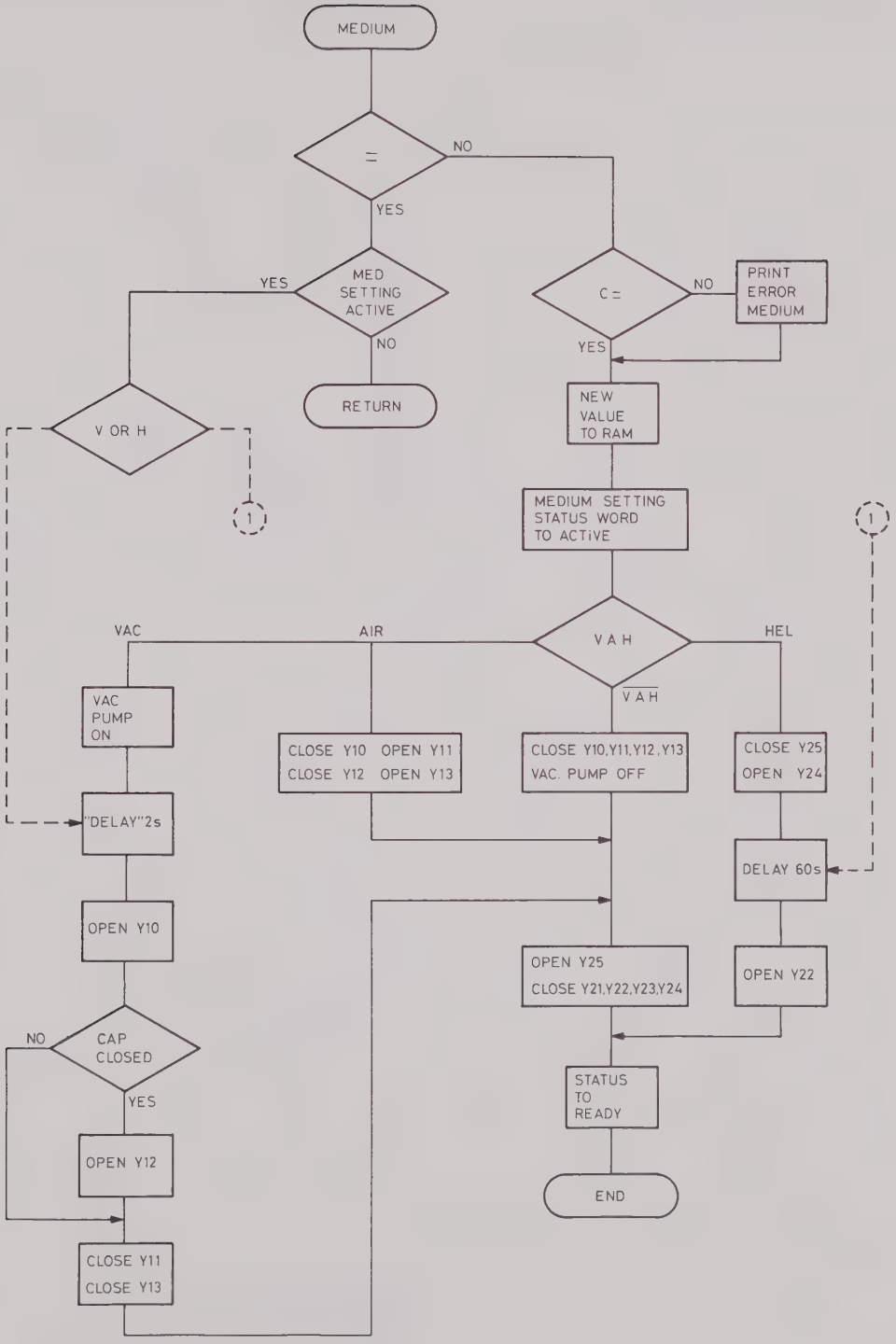
2. When either vacuum or helium has been selected, a delay is activated.
   In the case of the vacuum system this delay ensures that the main vacuum valve is not opened until 2 seconds after the vacuum pump is switched on.

   In the case of the helium system, the delay ensures that helium is allowed to enter the already evacuated system for 60 seconds before a continuous flow is established by opening the output valve Y22.

   NOTE

   When the system is filled with helium after a gas cylinder has been fitted or changed, evacuate and fill spectrometer twice. This will ensure that any air in the hose between the cylinder and the spectrometer is completely removed.

The lower part of the flow chart shows the actions carried out by the software/hardware depending on the switch selection.



KEY TO VALVES
Y10 CONTROL VALVE FOR MAIN VACUUM VALVE.
Y11 MAIN AIR INLET VALVE
Y12 VACUUM INLET VALVE FOR AIRLOCK
Y13 AIR INLET VALVE FOR AIRLOCK
Y21 HELIUM INLET VALVE FOR AIRLOCK
Y22 HELIUM OUTLET VALVE
Y23 HELIUM OUTLET VALVE FOR AIRLOCK
Y24 HELIUM INLET VALVE
Y25 CONTROL VALVE FOR MAIN HELIUM VALVE

RD5004
810901

Fig. 5 3.1.2. Flow chart-selection of spectrometer atmosphere.

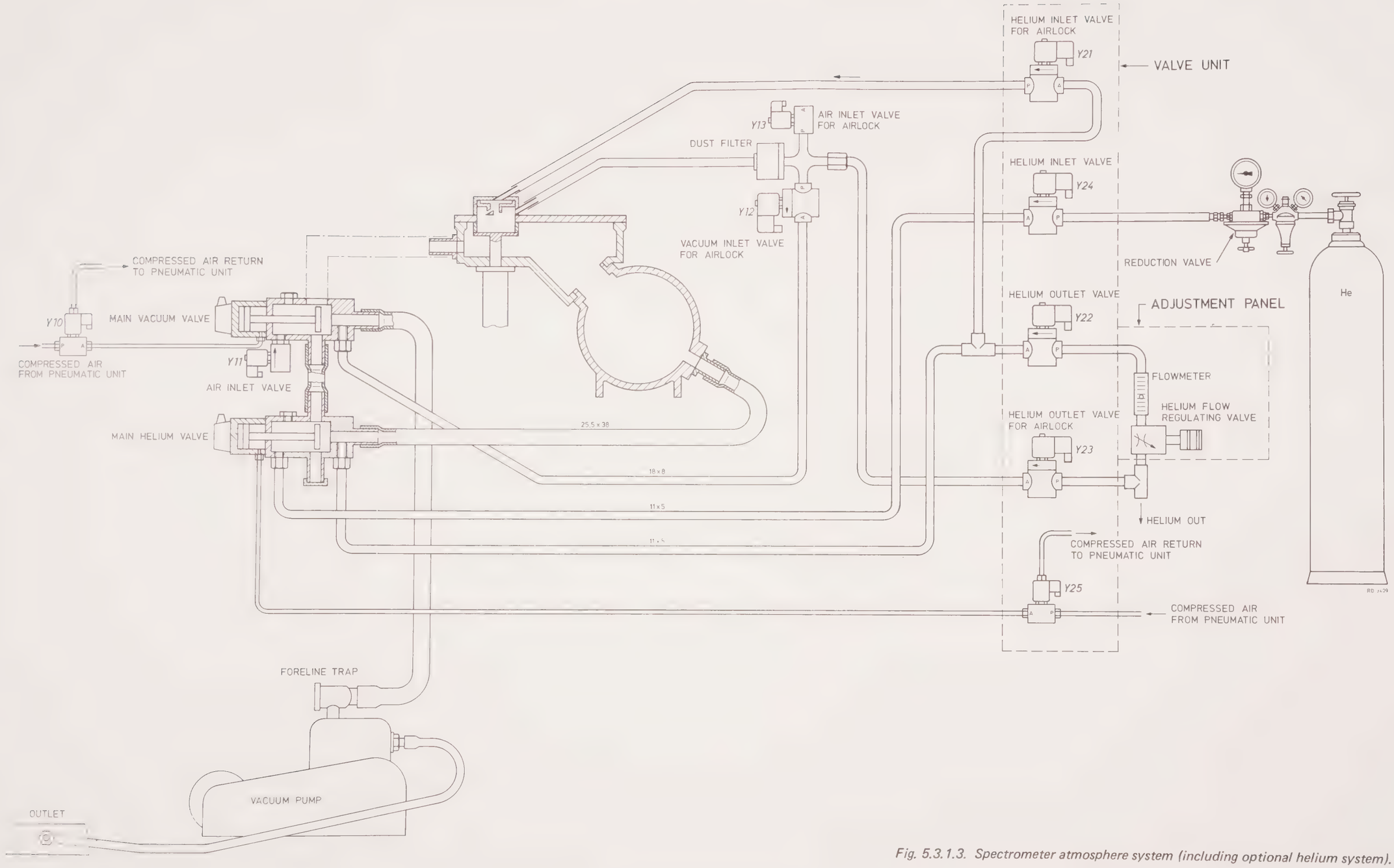


Fig. 5.3.1.3. Spectrometer atmosphere system (including optional helium system).

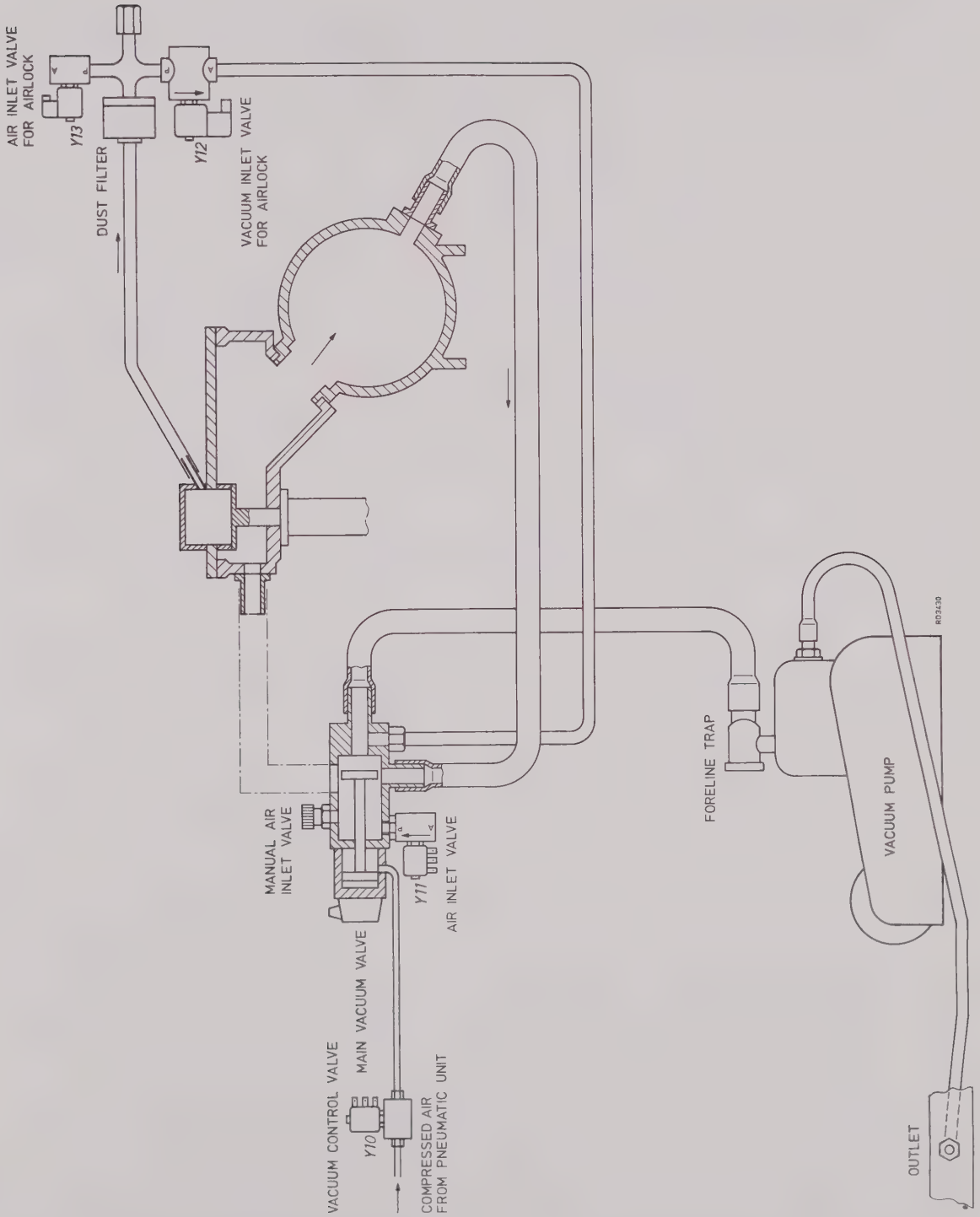


Fig. 5.3.1.4. Spectrometer vacuum system.

In the situation where no atmosphere is chosen, and when the spectrometer is switched off (VAH), the vacuum pump will be switched off and all valves will be closed. The whole system thus remains sealed.

The vacuum system also contains a manual air inlet valve, mounted on top of the main vacuum valve. To allow air to enter the system, turn the valve counterclockwise (see Fig. 8.2.6, item 210). The valve must also be closed by hand before the spectrometer can be evacuated, or filled with helium.

Fig. 5.3.1.5. shows the sequence of actions associated with loading a sample. A programmable delay is used:

1. With vacuum - for evacuating the airlock.
   This can be selected with the command STVn (n = 3-25, 5 seconds).
   In default of a setting being selected, a setting of 3 seconds will be automatically chosen.

2. With helium - for flushing the airlock.
   This can be selected with the command STH (n = 3-25, 5 seconds).
   In default of a setting being selected, a setting of 6 seconds will be automatically chosen.

If no choice of atmosphere has been made (VAH) when a sample is loaded, the message "ERROR MEDIUM" will be printed and the microprocessor program will be reset.

If, after the plunger has been lowered, the signal VACOK+ = 0, a delay of 10 seconds will be initiated before a measurement can be started. If, at the end of the measurement, VACOK+ = 0 the message "ERROR VACUUM" will be output.

When a sample is unloaded from an evacuated spectrometer a delay of 0.3 s is introduced to ensure that Y12 is fully closed before Y13 is opened. A second delay of 0.5 s ensures that air can enter the airlock before the cap is raised.

5.3.2. Main vacuum and main helium valves

The main vacuum valve and the main helium valve are both modifications of the same basic Edwards valve. This valve is operated by compressed air and contains a number of "O"-rings which are subject the wear and which must be renewed occasionally. Dynamic "O"-rings must be lightly coated with a lubricant such as Molykote 44 (see Chapter 8.6).

If the main vacuum valve is demounted from the sample chamber, this will break the seal between them. Thoroughly clean the sealing surfaces with petroleum ether and remount the valve using silicone rubber compound Silastic 732 (See chapter 8.6).

5.3.3. Manual air inlet valve (Edwards)

This valve is mounted on top of the main vacuum valve. It can be disassembled for cleaning and for replacement of the sealing washer (see Chapter 8.2.6.).

5.3.4. Electromagnetic vacuum/helium valves (Herion)

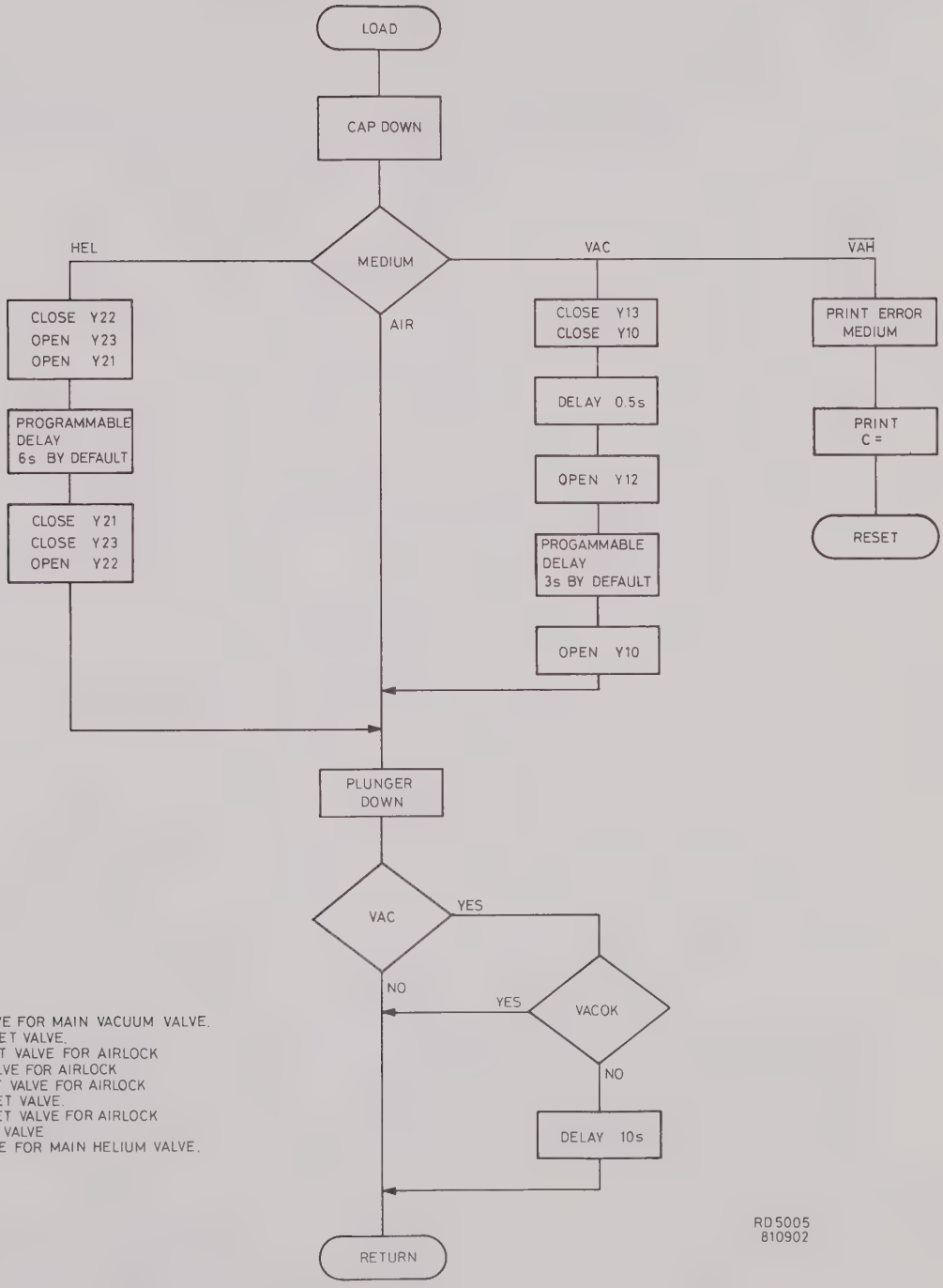
Two types of electromagnetic valve are used - the larger has a diaphragm as a sealing element while the smaller has an O-ring.

The hose connections to these valves are marked with the letters "A" and "P". Ensure, when these valves are reassembled in the spectrometer, that they are connected as shown in figures 5.3.1.3. and 5.3.1.4. Connected in this way the sealing provided by the valves will be improved by the vacuum.

5.3.5. Foreline trap

A foreline trap is mounted on the vacuum pump and connected between the pump and the main vacuum valve. Its purpose is to prevent any vapour from the vacuum pump oil getting into the vacuum system. It also tends to absorb any water vapour present in the air pumped from the vacuum system.

The trap is filled with activated alumina contained in a perforated metal basket.
The alumina charge has a long lifetime before it becomes saturated with oil vapour and must be renewed.



KEY TO VALVES:
Y10 CONTROL VALVE FOR MAIN VACUUM VALVE.
Y11 MAIN AIR INLET VALVE.
Y12 VACUUM INLET VALVE FOR AIRLOCK
Y13 AIR INLET VALVE FOR AIRLOCK
Y21 HELIUM INLET VALVE FOR AIRLOCK
Y22 HELIUM OUTLET VALVE.
Y23 HELIUM OUTLET VALVE FOR AIRLOCK
Y24 HELIUM INLET VALVE
Y25 CONTROL VALVE FOR MAIN HELIUM VALVE.

Fig. 5.3.1.5. Flow chart-sample loading.

If the alumina becomes saturated with water taken from the atmosphere, it can be dried by baking for a short time in an oven.

A can of activated alumina is supplied with the spectrometer. The ordering code for further supplies will be found in Chapter 8.6.

5.3.6. Airlock filter [fig. 8.2.10]

The airlock is evacuated via a filter which is mounted on the cup unit base plate. The purpose of this filter is to prevent dust particles entering the vacuum pump oil. The filter consists of a housing sealed with an O-ring, and containing a glass-fibre filter element (see chapter 8.6).

5.4. PNEUMATIC SYSTEM

5.4.1. Introduction

Many of the mechanical actions in the spectrometer are performed with the aid of compressed air actuators. Compressed air is supplied to the actuators via electromagnetic valves.

Fig. 5.4.1 is a schematic diagram of the compressed air system. The incoming air is supplied to a manifold to which is connected:

1. A pressure relief valve adjusted to open at approximately 4.5 atm. ($\approx 4.5 \times 10^5$ N/m^2). This valve prevents excessive pressures being accidentally applied to the system.

2. A pressure gauge indicating the applied pressure in bar (1 bar $\approx 10^5$ N/m^2) and 1 b/m^2 (1 lb/m$^2 \approx$ 6.89 x 10^3 N/m^2).

3. An adjustable pressure sensitive switch with a range 0 - 6.62 bar or 0 - 95 lb/in^2 (0 - 6.62 x 10^5 N/m^2). The switch forms part of the safety circuit, and causes the H.V. generator to be switched off if the required minimum air pressure is not reached. The switch is adjusted with a thumbwheel to 2.5 bar (2.5 x 10^5 N/m^2).

This manifold also has a spare position (at the lower end) to which the valve controlling the main helium valve (Y25) can be connected.

The inlet manifold is connected to two further manifolds to which all the other valves are connected.

A "Tee" piece is fitted in the compressed air supply line immediately behind the rear connecting panel on the PW 1400/00. It is intended for the connection of the PW 1505 or PW 1506 options – it can be reached after the lower electronic rack has been demounted.

For most of the applications 3/2 way valves are used in conjunction with double-action actuators. In order to operate these actuators, pressure must be applied in one direction whilst pressure is removed from the opposing direction. This entails the operation of two changeover valves – via one valve pressure is applied and via the other air is allowed to escape via a restriction in the exhaust hose, an exhaust manifold, and a silencer, to the surrounding atmosphere. The restriction ensures that the operating speed of the actuator is limited, thus protecting the driven mechanism from excessive shock.

5.4.2. Compressed air supply

Compressed air must be supplied via an external control valve and water trap (catch-pot). In addition, for spectrometers with serial numbers up to, and including, DY750 an external oil mister must be fitted. Starting with serial number DY751 an oil mister should not be fitted since all the actuators, except that for the plunger, are lubricated for life.

CAUTION

Ensure that only compressed air or nitrogen are connected to the system. The use of other gases, e.g. helium, can lead to damage.

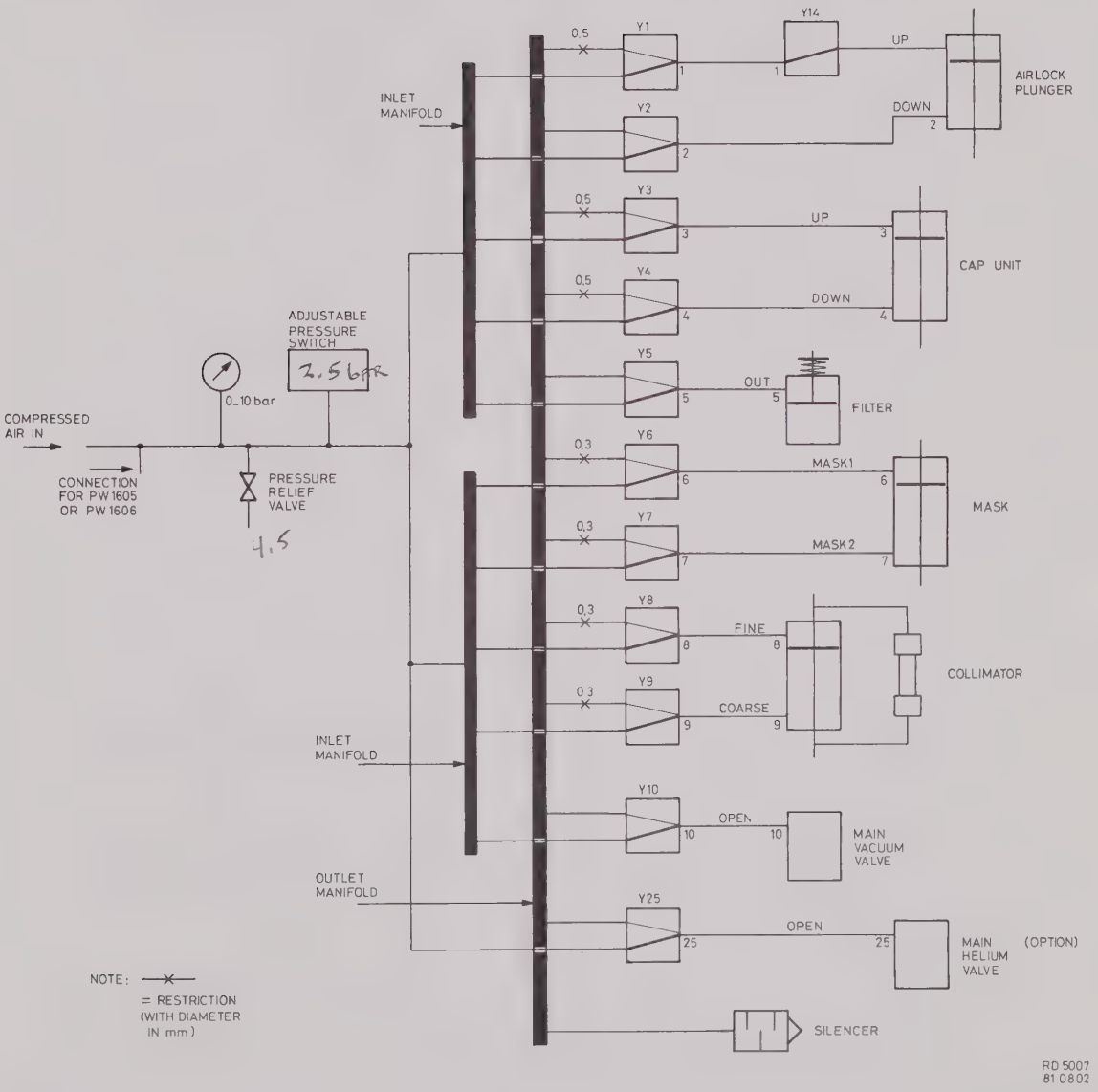


Fig. 5.4.1. Compressed air system — schematic diagram.

5.4.3. Restrictions

It is especially important to ensure, if hoses are renewed in the pneumatic system, that the correct restrictions are fitted in the appropriate hoses. Failure to do this could lead to damage to the spectrometer.

For those spectrometers which have an oil mister in the compressed air supply the restrictions and the hoses containing them may need occasional cleaning to remove any accumulated oil. This can best be done by removing the hoses, pouring a little alcohol into them, and blowing them out with clean compressed air.

The hoses are numbered at each end and the corresponding connections are marked with the same numbers, facilitating the replacement of the hoses in the correct position.

5.5. TEMPERATURE STABILIZATION SYSTEM AND X-RAY TUBE COOLING

5.5.1. Introduction

The temperature stabilization system consists of:

- a heater (500 Watts).
- two separately controlled coolers (water cooled heat exchangers), with air circulating fans. One of these (cooler 1) is mounted beneath the heater [see fig. 8.2.24] and the other (cooler 2) is mounted in the vertical dividing wall between the lower compartments in the spectrometer cabinet.
- an air circulating fan between the upper compartment and the vacuum pump compartment in the spectrometer cabinet.
- a temperature sensor (NTC resistor) mounted on the bracket carrying the goniometer lower end stop microswitches [see Fig. 8.2.11].
- an electronic proportional controller circuit, mounted on the miscellaneous control pcb (A38).

The X-ray tube cooling circuit consists of a simple hose connection supplying cooling water to the tube. It is connected in series with the cooling water circuit in the HT generator.

The temperature stabilization system maintains the temperature in the spectrometer cabinet within plus and minus 0.05^{o} of the set point. The set point must be chosen so that it is above the ambient temperature and within the control range of the system. The set point is correctly chosen when the "%" LED is continuously flashing (indicating that the system is operating within the linear control range) and the "C1" LED is switched on and off with a frequency of approximately 12/minute.
This indicates that the heater is operating at a low level and that cooler 1 is switching on and off regularly. Cooler 2 is only switched on if the temperature rises above the upper limit of the control range. If the temperature is below the lower limit of the control range, the LED "%" will be continuously indicating that the heater is full on.

5.5.2. Heater

The heater consists basically of a housing in which a heating element is mounted on insulators. Also mounted on one side wall of the housing is a push-button-resettable thermal cutout set to open at 62 - 68 ^{o}C.

When a new heating element (in the form of a mat) is fitted, ensure that it is carefully bent in a semi-circular form and attached without stress to the insulating strips.

5.5.3. Coolers

Two identical coolers are fitted in the spectrometer cabinet. They consist of a housing containing a heat exchanger. On one side of the cooler an air circulating fan is mounted so as to draw air through the cooler. The fans run continuously when power is supplied to the spectrometer (also in standby). The coolers are shown in Fig. 8.2.23.

Take great care when loosening and tightening the water connections to the coolers. Always use two spanners to avoid any stress on the heat exchanger element. The connections are of the cone-compression type and require no additional sealing medium.

5.5.4. Water valve unit

The water valve unit consists of two electromagnetic valves joined by a "tee" piece. Connected in parallel with the two valves is a by-pass valve which opens when the water pressure exceeds 5.7 psi (3.93×10^4 N/m^2). The water bypass ensures, for systems in which the X-ray tube cooling is connected in series with the temperature stabilization system, that cooling water can flow through the X-ray tube when both electromagnetic valves are closed (i.e. when the spectrometer is not being cooled). The water circuit is shown in fig. 9.2.21 and the water valve unit in fig. 8.2.22a.

The following points are important:

1. The joints of the water valve unit are sealed with adhesive. If any joint is disturbed it must be opened and the threads must be cleaned with a brass-wire brush. The joint must then be resealed with Loctite 542 (see Chapter 8.6).
2. To ensure the water pipes and the joints are not under stress, the angle which the "tee" piece between the two electromagnetic valves makes with the horizontal must be correct.
   The water valve unit must be assembled so that the "tee" piece is in contact with the mounting bracket.
3. The electromagnetic valves and the bypass valve must be correctly assembled in the unit.
   The electromagnetic valves are marked with the letters "P" and "A". They must be so connected that water flow enters the valve via the connection marked "P" and leaves it via that marked "A".
   The bypass valve is marked with a small arrow indicating the direction of water flow. It should also be marked "3 MP - 7.5" indicating the operating pressure.

5.5.5. External water bypass and flow limiter

When the system is connected with the cooling circuits of the spectrometer and the X-ray tube in series, water normally stops flowing when power to the X-ray tube is switched off. To ensure a continuous supply of cooling water for the spectrometer the external connections also include a bypass valve and a flow limiter.
The bypass opens when the water pressure exceeds 23.5 psi (1.62×10^5 N/m^2).
The flow limiter reduces the water flow to a maximum of 6 litres/minute.

Both the bypass and the flow limiter are marked with an arrow indicating the direction of flow and the bypass is marked, in addition, "3 MP - 23.5". The assembly is shown in Fig. 5.5.5.

The joints of the bypass valve and the flow limiter are sealed with adhesive. If any joint is disturbed it must be opened and the threads must be cleaned with a brass-wire brush.
The joint must then be resealed with Loctite 542 (see Chapter 8.6).

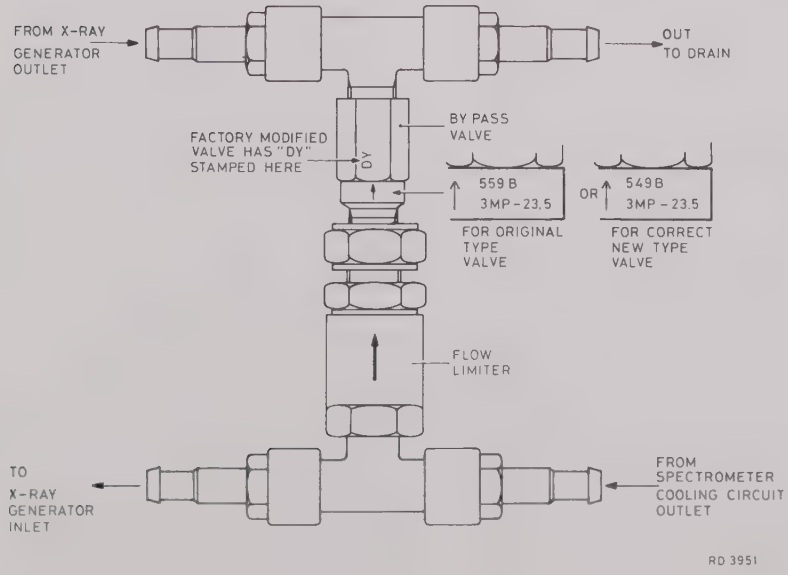


Fig. 5.5.5. Extend water bypass/flow limiter assembly.

5.5.6. Cleaning

1. Water filter

Except for systems with closed cooling units (e.g. Zephyr), the mains water must enter the system via a filter [see Fig. 3.11.1 and 3.11.2].
The filter cartridge can be cleaned and reused a number of times.

To remove collected contaminants wash the cartridge with water from a pressure hose.

To remove heavy organic matter soak the cartridge in a strong solution of tri-sodium phosphate and then wash with clean water.

To remove mineral scale, soak the cartridge in a 5 to 10 % solution of hydrochloric and (muriatic acid) and then wash with water from a pressure hose.

2. *X-ray tube*

Depending on the quality of the cooling water, mineral scale may form in the X-ray tube, particularly at the back of the anode.

To remove scale, fill the tube cooling circuit with a solution of 10 % acetic acid (CH_3COOH) in water and allow it to stand for about 15 minutes.
After this, flush the circuit thoroughly with clean water.

3. *Temperature stabilization system*

To remove scale, fill the whole cooling system with a solution of 10 % acetic acid (CH_3COOH) in water and allow it to stand for about 15 minutes. After this, flush the whole system thoroughly with clean water.

To ensure that both coolers are filled and flushed, both the valves Y16 and Y17 must be open. With power supplied to the spectrometer set the "TEMPERATURE" control fully counterclockwise - this will cause both valves to be opened.

4. *X-ray generator*

Scale can be removed from the cooling circuit of the X-ray generator in the same way as for the spectrometer.

To ensure that all the electromagnetic valves are open during filling and flushing, depress both pushbuttons "HIGH VOLTAGE" "1" and "0" together.

5.5.7. Water flow

For reasons of safety and stable operation it is necessary to have an adequate flow of cooling water. A water flow detector is fitted in the X-ray generator to ensure that if the water flow through the system is reduced below an acceptable limit, the HT will be switched off.

The water flow detector can be checked as follows:

- Connect the generator to the mains supply.
- Open the main water tap completely.
- Remove the lower rear panel from the generator.
- Switch on the mains by means of push button switch MAINS I on the frontpanel.
- Open the adjusting tap on the rear of the generator slowly until the H.T. can be switched on (the easiest way is to keep HV pressed).
  The water flow at that moment should be $\leqslant$ 4 l/min. $>$ 3.6 l/min.
- Close the adjusting tap slowly until the H.T. is switched off. The water flow at that moment should be $\geqslant$ 3.5 l/min. $<$ 4 l/min.

NOTES

1. *The water flow can be checked by means of a water flowmeter or as follows:*
   - *Remove the outlet hose from the main outlet.*
   - *Press HV I and HV O (magnetic watervalve opens but the H.T. is not switched on.*
   - *Let the water run into a bucket for 1 minute and check afterwards the amount of water in the bucket.*
2. *If a water bypass valve is fitted between the generator and the spectrometer, this must be disconnected to ensure that during the check all the water flows via the generator.*

5.6. DETECTOR GAS SYSTEM

5.6.1. Introduction

The detector gas system is shown schematically in Fig. 5.6.1. It's principal function is to ensure the presence of a constant number of gas molecules in the gas flow detector. Since the detector has a thin polypropylene window which is porous, a constant flow of gas must be provided to replace the losses. The flow rate of the gas (about 1 l/hr) is adjusted by the flow regulating valve (needle valve), which has a very high resistance to the flow, thus minimizing the effects of changes in atmospheric pressure.

A paper filter is fitted at the input to the system to remove any particulate matter in the gas.

An adjustable gas pressure switch produces a signal (DGLOW–) if the pressure falls below the setpoint (0.5 atm.). This causes the shut-off valve Y15 to be closed (GASOK– = 1).

A gas density stabilizer ensures that the density of the gas in the gas flow detector remains constant in spite of variations in temperature and pressure.

A gas leak sensor compares the rate of flow of gas entering and leaving the flow detector.
If these differ by more than 6 l/hr a signal is produced (GASOK– = 1) which causes the shut-off valve Y15 to be closed.

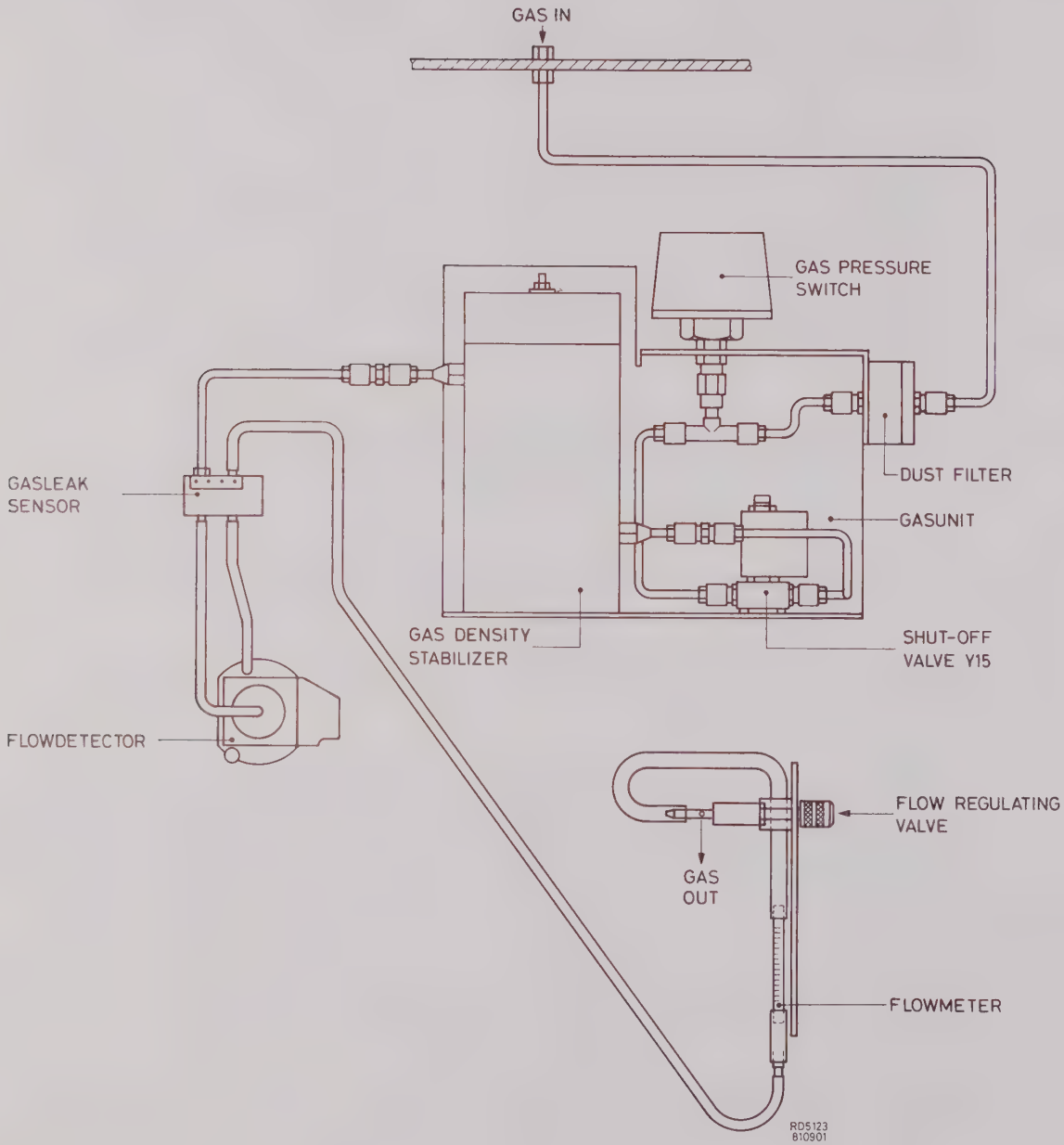


Fig. 5.6.1. Detector gas system.

5.6.2. Dust filter

5.6.2.1. Introduction

The dust filter is mounted on the gas unit and can be reached from the rear of the spectrometer. It consists of a housing and a cover sealed with an "O"-ring and attached to each other with screws. Within the housing is a paper filter element sandwiched between two perforated support discs and held in place with a loose support ring. The filter is sealed with an O-ring which fits in a groove formed by the loose ring and the housing.
The components are shown in Fig. 8.2.16.

5.6.2.2. Filter element

The filter element is a paper disc printed on one side with a pattern of lines forming squares.
It is of no importance which direction the element faces with respect to the direction of gas flow.

CAUTION

When replacing the filter element ensure that all filter components remain scrupuously clean to avoid contamination of the detector gas.

For replacement elements see chapter 8.6.

5.6.2.3. Cleaning

The best way to clean the filter components is to immerse then in an ultrasonic cleaning bath containing petroleum ether. If this is not possible, clean the components with petroleum ether, taking care not to handle them with the fingers after cleaning.

CAUTION

To avoid subsequent contamination of the gas and hence of the flow detector:
1. **Do not use alcohol, acetone, or any solvent other than petroleum ether for cleaning.**
2. **Do not use any kind of grease on the O-ring.**

5.6.3. Gas pressure switch

The gas pressure switch is a device having an adjustable switching point with separately adjustable hysteresis.

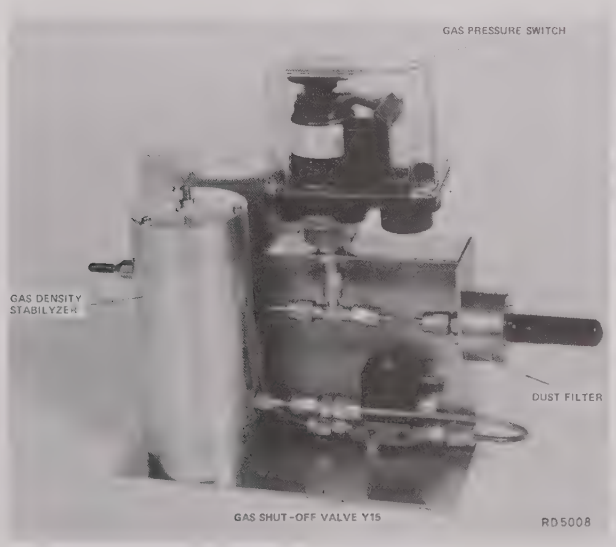


Fig. 5.6.3.a. Gas unit assembly

Fig. 5.6.3.b. Gas pressure switch

The adjustment procedure is as follows:

1. Remove the locking pin from the adjustment wheel [see Fig. 5.6.3.c.].

Fig. 5.6.3.c. Removal of locking pin.

2. Ensure that gas is flowing through the system (1 l/hr). If necessary, rotate the adjustment wheel to achieve this.

3. Disconnect the wires to the terminal block on the pressure switch and connect a multimeter set to the ohms range.

4. Adjust the pressure at the reduction valve on the gas cylinder to 0.7 atm.

5. Rotate the adjusting wheel until the switch contacts just open (multimeter indicates ∞).

6. Refit the locking pin (two positions are provided on the switch body, one of which should be in line with a hole in the adjusting wheel).

7. Reduce the gas pressure to 0.4 atm. The switch contacts should just close (multimeter indicates 0). If they do not, press down the adjusting wheel and rotate the hexagon-head screw in its centre until the switch contacts just close. This sets the hysteresis of the pressure switch [see Fig. 5.6.3.d.].

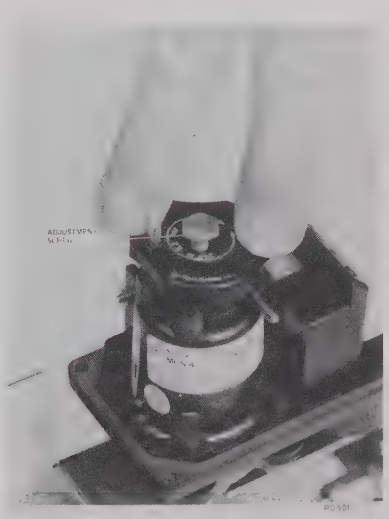


Fig. 5.6.3.d. Hysteresis adjustment screw.

8. Check that the switch contacts open when the gas pressure is increased to 0.7 atm. and close when the pressure is reduced to 0.4 atm.

9. Reconnect the wires to the terminal block.

5.6.4. Shut-off valve Y15

This valve consists of a two-chamber body and a stem containing the operating elements.
The stem is fitted with two O-rings, one sealing it to each chamber. The stem can be unscrewed from the chamber and the O-rings can be renewed if necessary.

The valve body may be cleaned, preferably in an ultrasonic cleaning bath containing petroleum. Do not clean the valve stem with freon as this can damage the valve seating; freon can also cause contamination of the detector gas.

If this valve is contaminated it should be replaced with a new one, since cleaning the valve stem successfully is virtually impossible. Before fitting a new valve, disassemble it and clean the valve body as previously described.

5.6.5. Gas density stabilizer

5.6.5.1. Introduction

Fig. 5.6.5.1. shows a sectional view of the gas density stabilizer. The stabilizer consists of a chamber, to which a bellows is attached at one end. The other end of the bellows carries a plunger rod which operates a lever, hinged at one end. The free end of the lever operates against a loose conical valve which regulates the flow of detector gas entering the chamber via the valve seating.

The bellows is filled with a fixed quantity of dry gas and is hermetically sealed.

Since the volume of the bellows (V_b) remains constant, the gas pressure within the bellows (P_b) and hence the length of the bellows, is proportional to the absolute temperature (T).

$$\text{i.e. } P_b = kT$$

The valve regulates the flow of gas so that the pressure in the chamber P_v is equal to the pressure in the bellows (P_b), so that:

$$\text{i.e. } P_v = kT$$

After passing through the gas flow detector the gas passes through a flow adjusting valve to the surrounding atmosphere.
The resistance of this valve to the gas flow is very high in comparison with the resistance of the rest of the gas circuit, so that the pressure of the gas in the detector is practically equal to the pressure (P_v) in the stabilizer (i.e. the effect of atmospheric pressure is negligable).

If the gas flow detector and the gas density stabilizer both have the same temperature, the pressure equalization ($P_b = P_v$) also results in a stabilization of gas density in the flow detector (i.e. the number of molecules of gas in the fixed volume of the detector remains constant). A change of 1 % in gas density results in change of 6 % in the detected X-ray intensity; for this reason it is particularly important that the temperature within the whole spectrometer cabinet be stabilized.

The high resistance of the adjusting valve to the flow of gas also means that small changes in atmospheric pressure will have a negligable effect on gas density in the flow detector.

5.6.5.2. Cleaning

Cleaning will usually be limited to the conical valve and the valve seating. This should be done with petroleum ether and a small brush. For this purpose only the cover at the bottom of the stabilizer housing should be opened.

If more extensive cleaning is required, the stabilizer can be further disassembled by carefully pressing out the pin which passes through the hinged lever and the plunger rod and removing the top cover with the bellows attached. The whole assembly and the housing can then be cleaned with petroleum ether. Ensure that the petroleum ether has fully evaporated before reassembling the stabilizer.

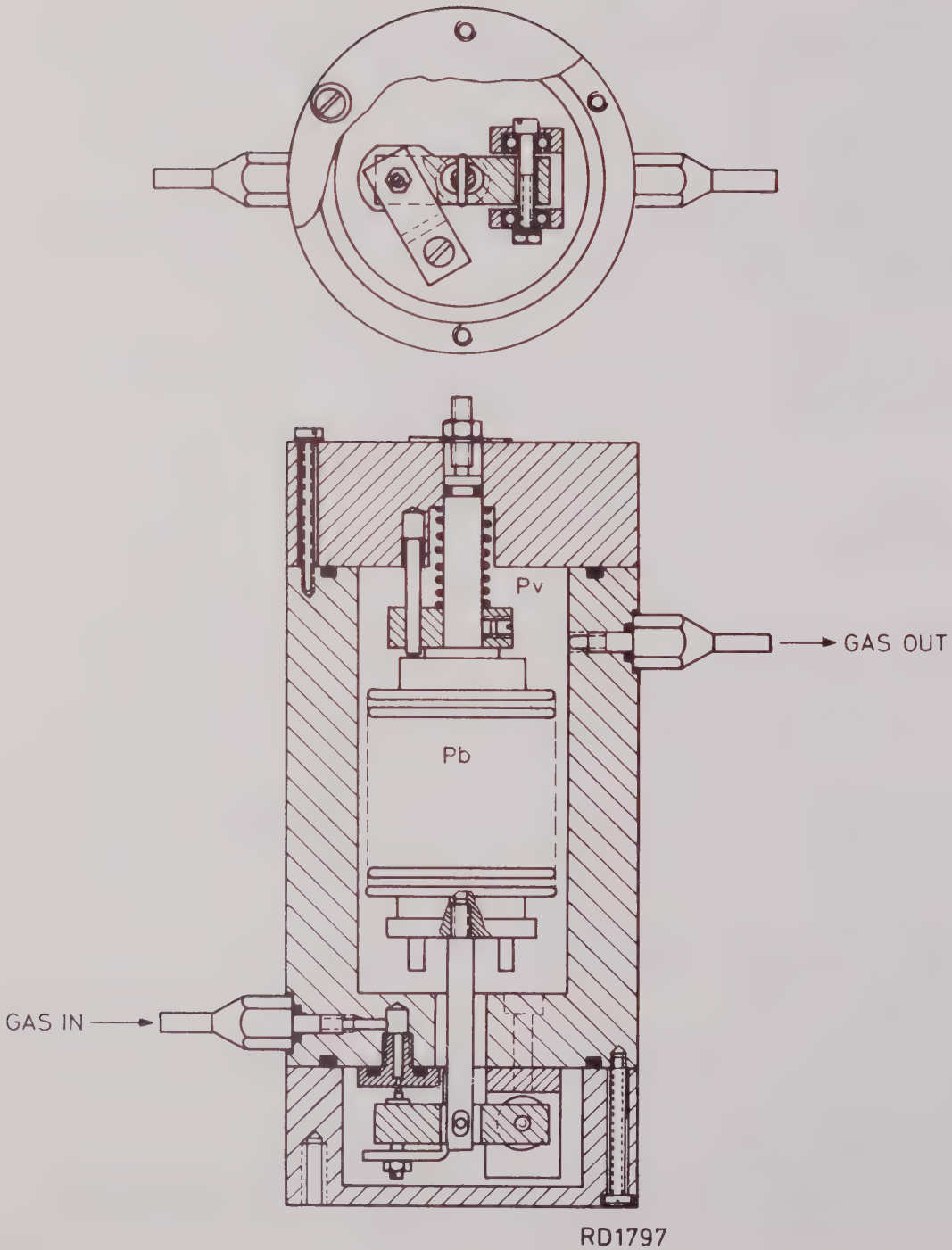


Fig. 5.6.5.1. Gas density stabilizer.

CAUTION

1. **Do not use any solvents other than petroleum ehter for cleaning as these can cause contamination of the detector gas.**
2. **Do not use grease on any of the O-rings.**
3. **Do not loosen the paint-sealed adjusting nut on the top cover.**

5.6.5.3. Disassembly

In order to disassemble the stabilizer so that a new bellows can be fitted it will first be necessary to remove the pin (Fig. 8.2.17 [29]) which attaches the bellows plunger rod to the valve operating lever [30]. This pin is held in position on both sides of the lever by indentations made with a centre punch.
Remove it carefully by pressing or tapping it out whilst the lever is supported on a block with a hole in it.

When the pin has been removed, the screws holding the top cover [14] can be removed. Withdraw the cover, with the bellows attached, from the stabilizer body.

Unscrew the nut [17] and withdraw the bellows from the cover. Remove the O-ring [11] and discard it.

Loosen the set screw [20] and remove the locating block [18] from the upper shaft of the bellows assembly. Take care not to lose the loose brass locking pad [19], which may then fall out.

5.6.5.4. Assembly of new bellows

1. Check the length of the bellows. The overall length between the outermost flat surfaces must be 61 - 33 mm.

2. Place the locating block on the upper shaft of the bellows so that it is in contact with the flange.

3. Insert the brass locking pad and set screw, position the locating block on the shaft so that the set screw is at 90^{o} to the hole in the lower shaft (plunger rod), and tighten the set screw.

4. Fit the O-ring [11] in the groove in the shaft.

   CAUTION

   Ensure that all components, including the O-ring, are clean and free from grease.

5. Fit the compression spring [13] to the upper bellows shaft and insert the shaft in the central hole in the cover [14] so that the guide pin in the upper flange of the bellows enters the guide hole in the lower side of the cover.

6. Place the washer [16] and the nut [17] on the shaft and tighten the nut until the flange of the bellows is in contact with the cover.

7. Check that the bellows shaft and the guide pin move freely in the cover by loosening the nut as fully as possible and then retightening it.

8. Place a clean, grease-free O-ring [9] in the groove in the housing and mount the cover so that the hole in the bellows operating shaft and the hole in the lever [30] are aligned.

9. Lay the assembly on a table with the lever resting on a support block so that the hole in the lever is uppermost.

10. Carefully tap the pin [29] into position with a light hammer, and using a centre punch, slightly deform the pin at both ends to prevent it falling out.

11. Place the conical pin [31] in position, loosening the nut [17] as necessary to achieve this.

12. Check that the set screw [4] comes opposite the centre of the lever [30] and that the screw [6] is tight.

13. Using a feeler gauge, adjust the set screw [4] so that the distance between the screw and the lever is 0.3 mm.

14. Check that the conical pin [31] cannot fall out of the valve seat [7].

15. Place a clean, grease-free O-ring [9] in the groove in the housing [12] and screw the bottom cover [3] in position.

5.6.5.5. Adjustment and test procedure

5.6.5.5.1. Preparation

For the adjustment procedure the following items are required:

Cylinder of detector gas (90 % Argon, 10 % Methane)	
Open water manometer (made from glass tube)	
Fluorubber hose	5322 530 20287
Dust filter	
Reduction valve	5322 360 50215
Needle valve	5322 360 54063
Gas flowmeter	5322 530 34047
Mercury thermometer (laboratory grade) for determining room temperature	
Barometer, for determining local barometric pressure	
Chronometer	

Connect the necessary items, together with the gas density stabilizer to be adjusted/tested, as shown in fig. 5.6.5.5.1.

CAUTION

This procedure should only be attempted if good workshop facilities and personnel with adequate mechanical skill are available. The adjustment is critical. If the procedure cannot be carried out with certainty, use a stabilizer obtained by means of the factory repairs procedure.

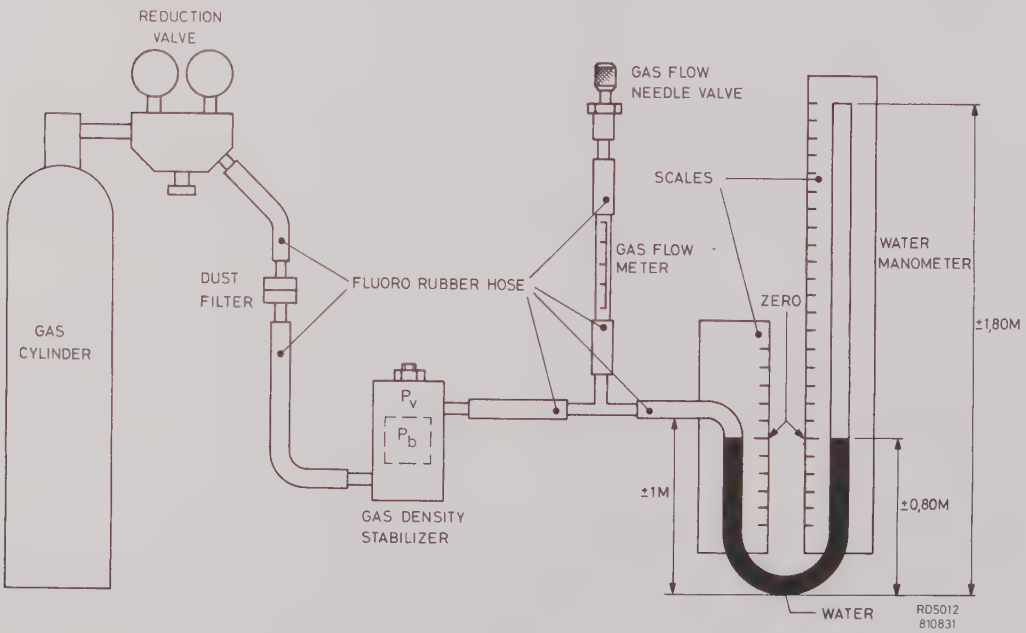


Fig. 5.6.5.5.1. Test arrangement

Before connecting the hoses, check that the water in the manometer is at the zero point of the scales on both arms.

5.6.5.5.2. Check for valve closure

1. Check that the primary pressure in the gas cylinder is $>$ 1 MPa (10 bar).

2. Adjust the secondary gas pressure on the reduction valve to 50 kPa (0.5 bar).

3. Ensure that the gas flow needle valve is fully closed (no gas flow) and increase the secondary gas pressure to the maximum (250 kPa (2.5 bar)).
   There must be no increase in the level in the manometer.

4. Keeping the maximum secondary gas pressure, open the needle valve fully. No gas may flow through the flowmeter.

5. If the height of the water column changes (step 3) or the flowmeter indicates a gas flow (step 4) this indicates that the conical pin [31] is not properly sealing the hole in the valve seat [7]. In this event, carefully tighten the nut [17] until the gas flow steps.

   If the flow cannot be stopped by tightening the nut, check the condition of the valve seat and the conical pin and renew them if necessary (see chapter 8.2.17).

5.6.5.5.3. Adjustment procedure

1. Note the room temperature and the corresponding pressure (P_V) from table 5.6.5.5.3.a.

2. Note the barometric pressure (P_{bar}) and the corresponding pressure in cm water from table 5.6.5.5.3.b).

3. Adjust the secondary gas pressure to 50 kPa (0.5 bar).

4. Calculate the correct height of the water column in the manometer using the formula.

$$h = P_V - P_{bar}$$

See fig. 5.6.5.5.3.

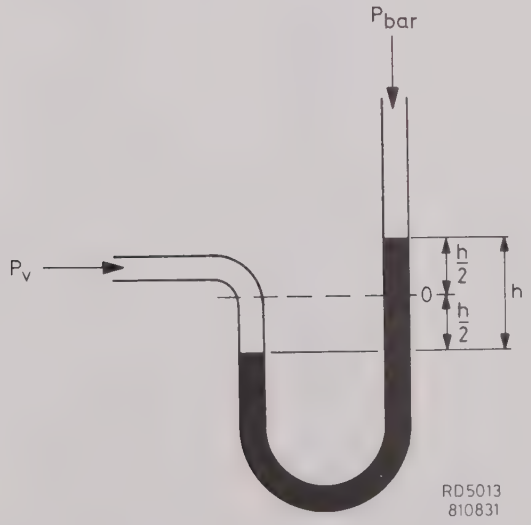


Fig. 5.6.5.5.3. Water manometer

14. Check that the conical pin [31] cannot fall out of the valve seat [7].

15. Place a clean, grease-free O-ring [9] in the groove in the housing [12] and screw the bottom cover [3] in position.

5.6.5.5. Adjustment and test procedure

5.6.5.5.1. Preparation

For the adjustment procedure the following items are required:

Cylinder of detector gas (90 % Argon, 10 % Methane)	
Open water manometer (made from glass tube)	
Fluorubber hose	5322 530 20287
Dust filter	
Reduction valve	5322 360 50215
Needle valve	5322 360 54063
Gas flowmeter	5322 530 34047
Mercury thermometer (laboratory grade) for determining room temperature	
Barometer, for determining local barometric pressure	
Chronometer	

Connect the necessary items, together with the gas density stabilizer to be adjusted/tested, as shown in fig. 5.6.5.5.1.

CAUTION

This procedure should only be attempted if good workshop facilities and personnel with adequate mechanical skill are available. The adjustment is critical. If the procedure cannot be carried out with certainty, use a stabilizer obtained by means of the factory repairs procedure.

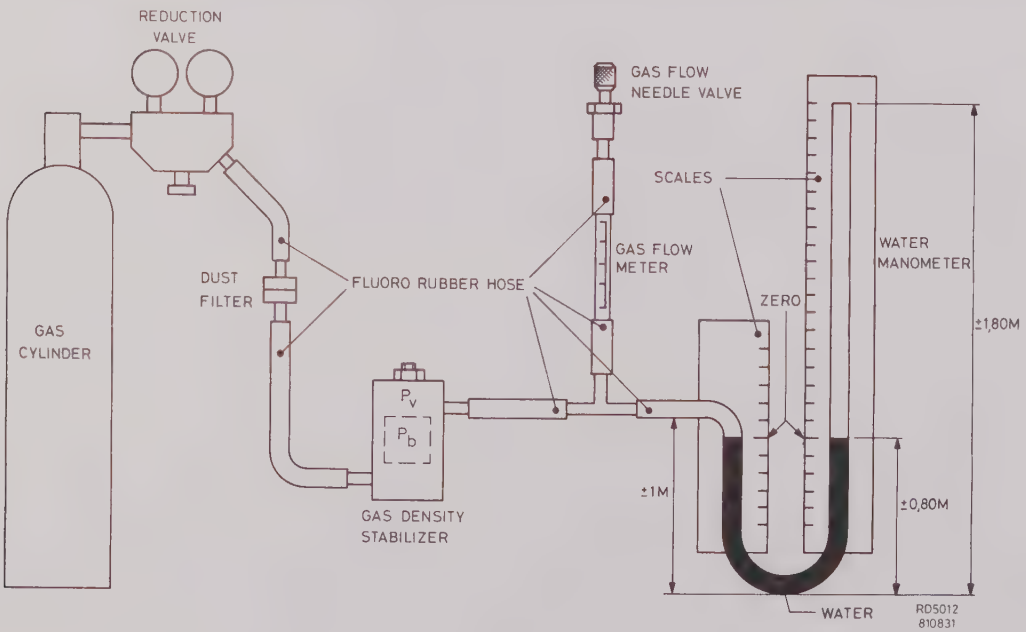


Fig. 5.6.5.5.1. Test arrangement

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   If the flow cannot be stopped by tightening the nut, check the condition of the valve seat and the conical pin and renew them if necessary (see chapter 8.2.17).

5.6.5.5.3. Adjustment procedure

1. Note the room temperature and the corresponding pressure (P_V) from table 5.6.5.5.3.a.

2. Note the barometric pressure (P_{bar}) and the corresponding pressure in cm water from table 5.6.5.5.3.b).

3. Adjust the secondary gas pressure to 50 kPa (0.5 bar).

4. Calculate the correct height of the water column in the manometer using the formula.

$$h = P_V - P_{bar}$$

See fig. 5.6.5.5.3.

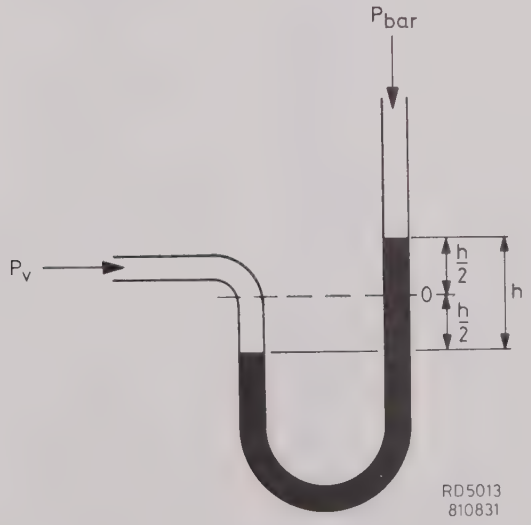


Fig. 5.6.5.5.3. Water manometer

Table 5.6.5.5.(a) Relationship of temperature to gas pressure.

Temperature ^{o} Celsius	P_v cm water
15^{o}C	1097
16^{o}C	1100
17^{o}C	1105
18^{o}C	1109
19^{o}C	1112
20^{o}C	1116
21^{o}C	1120
22^{o}C	1124
23^{o}C	1128
24^{o}C	1131
25^{o}C	1136
26^{o}C	1139
27^{o}C	1142
28^{o}C	1146
29^{o}C	1150
30^{o}C	1154
31^{o}C	1158
32^{o}C	1161
33^{o}C	1166
34^{o}C	1170
35^{o}C	1173
36^{o}C	1177
37^{o}C	1181
38^{o}C	1185
39^{o}C	1189
40^{o}C	1192

Table 5.6.5.5.3(b)

P(bar) kPa	P(bar) cm water
97,0	989,48
97,1	990,50
97,2	991,52
97,3	992,54
97,4	993,56
97,5	994,58
97,6	995,60
97,7	996,62
97,8	997,64
97,9	998,66
98,0	999,68
98,1	1000,70
98,2	1001,72
98,3	1002,74
98,4	1003,77
98,5	1004,79
98,6	1005,81
98,7	1006,83
98,8	1007,85
98,9	1008,87
99,0	1009,89
99,1	1010,91
99,2	1011,93
99,3	1012,95
99,4	1013,97
99,5	1014,99
99,6	1016,01
99,7	1017,03
99,8	1018,05
99,9	1019,07
100,0	1020,09
100,1	1021,11
100,2	1022,13
100,3	1023,15
100,4	1024,17
100,5	1025,19
100,6	1026,21
100,7	1027,23
100,8	1028,25
100,9	1029,27
101,0	1030,29
101,1	1031,31
101,2	1032,33
101,3	1033,35
101,4	1034,37
101,5	1035,39
101,6	1036,41
101,7	1037,43
101,8	1038,45
101,9	1039,47
102,0	1040,49
102,1	1041,51
102,2	1042,53
102,3	1043,55
102,4	1044,57
102,5	1045,59
102,6	1046,61
102,7	1047,63
102,8	1048,65
102,9	1049,67
103,0	1050,69
103,1	1051,71
103,2	1052,73
103,3	1053,75
103,4	1054,77
103,5	1055,79
103,6	1056,81
103,7	1057,83
103,8	1058,85
103,9	1059,87
104,0	1060,89
104,1	1061,91
104,2	1062,93
104,3	1063,95
104,4	1064,97
104,5	1065,99
104,6	1067,01
104,7	1068,03
104,8	1069,05
104,9	1070,07
105,0	1071,09

Table 5.6.5.5.3.(c)

P(bar) mm Hg	P(bar) cm water		
730	992,80	785	1067,60
731	994,16	786	1068,96
732	995,52	787	1070,32
733	996,88	788	1071,68
734	998,24	789	1073,04
735	999,60	790	1074,40
736	1000,96		
737	1002,32		
738	1003,68		
739	1005,04		
740	1006,40		
741	1007,76		
742	1009,12		
743	1010,48		
744	1011,84		
745	1013,20		
746	1014,56		
747	1015,92		
748	1017,28		
749	1018,64		
750	1020,00		
751	1021,36		
752	1022,73		
753	1024,08		
754	1025,44		
755	1026,80		
756	1028,16		
757	1029,52		
758	1030,88		
759	1032,24		
760	1033,60		
761	1034,16		
762	1036,32		
763	1037,68		
764	1039,04		
765	1040,40		
766	1041,76		
767	1043,12		
768	1044,48		
769	1045,84		
770	1047,20		
771	1048,56		
772	1049,42		
773	1051,28		
774	1052,64		
775	1054,00		
776	1055,36		
777	1056,72		
778	1058,08		
779	1059,44		
780	1060,80		
781	1062,16		
782	1063,52		
783	1064,88		
784	1066,24		

5. Adjust the nut [17] until the height of the water column is equal to the calculated value h.

6. Adjust the needle valve until the flowrate is 1 litre/hour.

7. Allow the system to stabilize for at least two minutes.

8. If necessary, repeat the adjustment of step 5.

5.6.5.5.4. Functional test

1. Close the needle valve fully so that the gas flowmeter indicates zero.

2. Over a period of two minutes the height of the water column in the manometer may not increase by more than 25 mm. If the height increases by more than this it is an indication of inaccuracy of the hole in the valve seat [7] or of the conical pin [31].

5.6.5.5.5. Stability test

1. Adjust the needle valve so that the flowrate is 1 litre/hour.

2. The water column in the manometer must return to the setting which it had in 5.6.5.4.3 step 8. If it does not, readjust the nut [17] until the column assumes the correct calculated height.

3. Adjust the secondary pressure to 20 kPa (0.2 bar). The flowrate must remain at 1 litre/hour.

4. During the following two minutes the height of the water column in the manometer may not decrease by more than 10 mm from the correctly adjusted height.

5. Adjust the secondary pressure to 100 kPa (1.0 bar).

6. During the following two minutes the height of the water column in the manometer may not increase by more than 10 mm from the correctly adjusted height.

5.6.5.5.6. Regulation test

1. Adjust the secondary gas pressure to 50 kPa (0.5 bar).

2. If necessary adjust the nut [17] to obtain the correct height of the water column in the manometer according to 5.6.5.5.3. steps 4 and 5.

3. Using the needle valve, vary the gas flow between 0.5 and 3.0 litres/hour. Over this range the height of the water column in the manometer may not vary by more than 2 mm from the previously adjusted height.

After completing the tests, ensure that the input and output pipes are sealed to prevent dirt entering the gas density stabilizer.

5.6.6. Gas flow detector

5.6.6.1. Introduction

The gas flow detector is an X-ray detector designed to measure radiation from light elements (i.e. radiation with a wavelength greater than 2 A, FeKα, although it can be used for radiation with wavelengths greater than 1 Å). It consists of a roughly cylindrical body at earth potential with an anode wire stretched along the electrical center line at a high positive potential. The body is provided with entrance and exit windows of polypropylene foil (1 μm or 6 μm thick) having a very thin coating of aluminium. The entrance window is held in position by a collimator, and the exit window by a beryllium support window.

The detector is supplied with a flow of gas via the gas density stabilizer such that the number of molecules of gas within the detector remains constant. A flow of gas (1 litre per hour) is necessary to replace the gas lost via the ultra-thin (and thus very slightly porous) windows.

An extension to the detector housing contains a preamplifier.

A sectioned view of the gas flow detector is shown in Fig. 5.6.6.1.1.

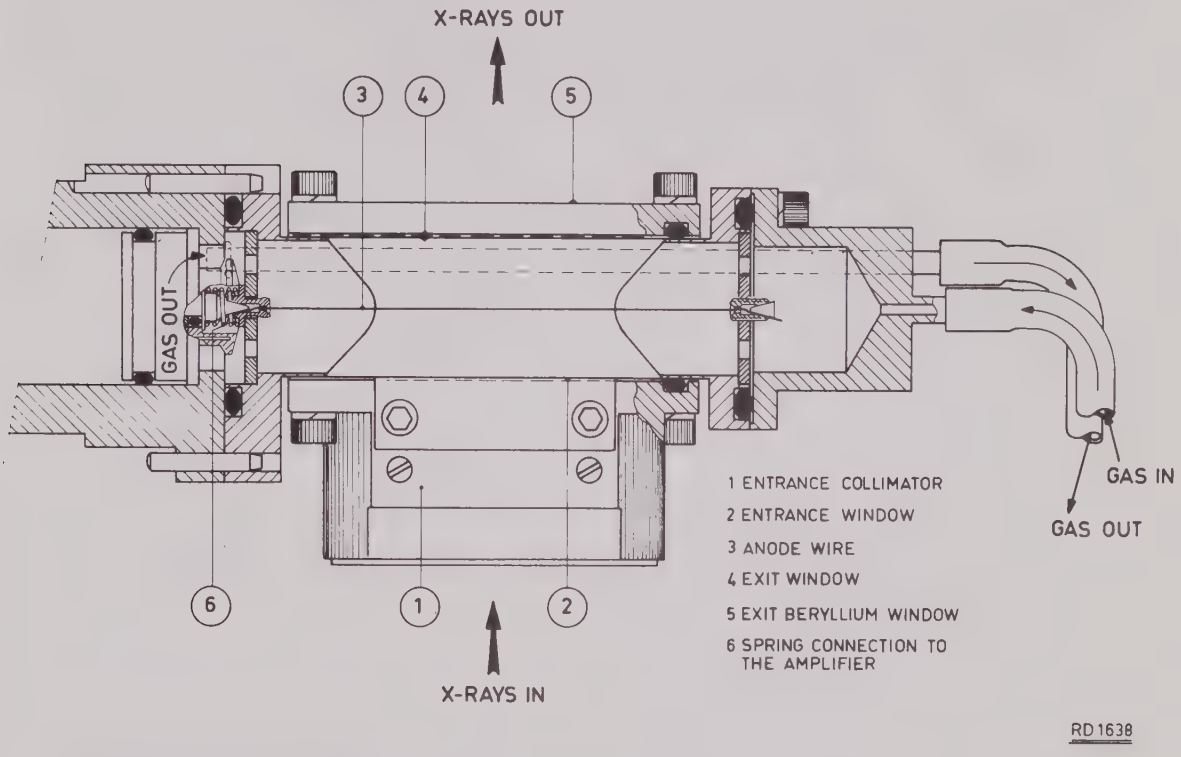


Fig. 5.6.6.1.1. Gas flow detector

An X-ray photon entering the detector ionizes the gas. Owing to the high anode potential, the electron released during this initial ionization is accelerated towards the anode, and causes ionization of further gas molecules. This process proceeds in avalanche (gas amplification) until all the electrons so produced reach the anode. The principle of the detector is shown schematically in Fig. 5.6.6.1.2.

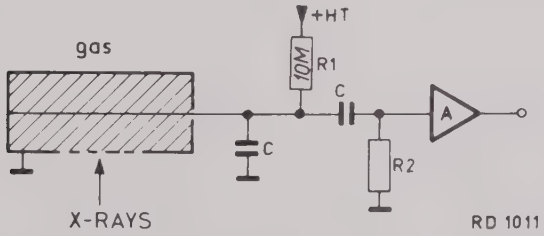


Fig. 5.6.6.1.2. Principle of gas flow detector.

The electrons reaching the anode cause a reduction in its potential which is amplified and appears at the preamplifier output as a voltage pulse. The amplitude of the pulse so produced is proportional to the energy (wavelength) of the incoming X-ray photon.

5.6.6.2. Demounting [Fig. 8.2.14]

The gas flow detector is attached by a bracket to the 2θ shaft of the goniometer. The detector can be demounted after removing the screws [23], which attach it to the bracket [20]. In addition to the screws, the detector is positioned on the bracket with dowel pins.

The amplifier housing [24] is attached to the detector body by two screws [9]. If only the windows or the anode wire need to be replaced, the body with the collimator can be detached, leaving the amplifier in its housing attached to the crystal chamber by the hose carrying the electrical connections.

NOTE

If the body is detached from the amplifier housing, be careful not to lose the contact spring [27].

The electrical connections to the detector pass through a hose attached to the gas leakage sensor, and hence to the detector connection pcb where they are soldered to terminals.
If it is necessary to demount the preamplifier, the solder connections must first be detached.

5.6.6.3. Non routine maintenance

5.6.6.3.1. Cleaning

The detector body must be cleaned using petroleum ether as a solvent.

CAUTION

Do not use other solvents for cleaning as the residues of these can act as quench gases and seriously affect the operation of the detector.

5.6.6.3.2. Detector windows

The efficiency of a gas flow detector depends to a large extent on the window used; the window should allow radiation to pass with the minimum of absorption.
A polypropylene window of 6 μm is commonly used for measuring radiation of wavelengths less than 8 Å.
Beyond this unit, i.e. for softer radiation, the absorption of the polypropylene becomes more important and for extremely light elements a polypropylene window of 1 μm is used.
The table below gives the approximate relationship between the intensities obtained with the two windows.

Elements	Atomic number	λ K Å	6 μm polypropylene	1 μm polypropylene
Si	14	7.126	1	1.5
Al	13	8.339	1	1.9
Mg	12	9.889	1	3.5
Na	11	11.909	1	9

Using very thin windows poses certain mechanical problems. A sheet of 1 μm thickness is delicate and tears easily. Thus care must be taken to ensure that the detector casing and the input collimator blades are well finished.

A window made only of plastic material would cause a discontinuity of the electrical field inside the detector and the window would become charged with ions. This would have a bad effect on the resolution of the detector. To overcome these problems the inside surface of the window is given a very thin coating (100 - 200 Å) of aluminium.

As a general rule, always fit a 6 μm thick entrance window unless elements lighter than magnesium are to measured.

Always fit a 6 μm thick exit window.

Flow detector windows are supplied packed between two glass plates within a vacuum-sealed plastic/aluminium bag. To fit a new window use the following procedure:

1. Open the sealed plastic/aluminium bag with a pair of scissors, remove the window in its glass sandwich, and place it on a flat surface with the visible brass frame of the window facing downwards (See Fig. 5.6.6.3.2).

2. With a sharp knife cut through the transparent adhesive tape on one side and open the sandwich by turning the upper glass plate over, using the remaining piece of adhesive tape as a hinge.

3. Remove the card frame.

4. Wait at least one minute for the window to loosen from the glass. This time must be allowed for air to enter the previously evacuated space between the window and the glass plate.

5. With a sharp knife very carefully loosen the four corners of the brass frame by sliding the sharp edge of the knife firmly over the glass towards the corner of the frame. Remove the window from the glass.

6. If mechanical breakdown of the previous window has occurred, check the collimator for the following points 7 to 13 inclusive.

7. The blades and distance pieces must be in contact with the brass mask on the collimator, i.e. the blades on the window side must all be positioned equally high.

8. The blades and distance pieces must not be displaced with respect to each other, and the distances between the blades must be equal.

9. The distance pieces must not be visible in the central opening of the brass mask.

10. The edges of the collimator blades and the brass mask must be smooth and free from burrs.

11. No residue of adhesive must be present on the brass mask.

12. The collimator blades must be parallel with the long edge of the mask.

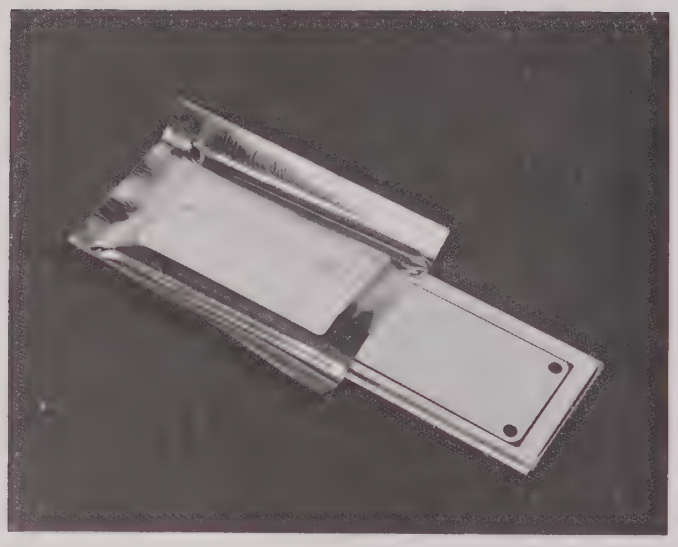
13. The blades must be flat and parallel with each other.

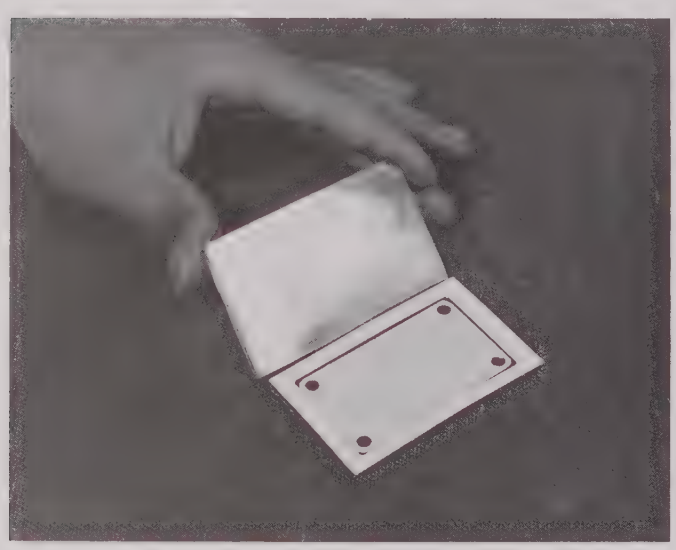
14. Carefully remove all dust from the flow detector housing and collimator with a clean dry brush.

15. Place the window carefully on the flow detector housing with the brass frame (which is attached to the aluminium conducting-layer side) facing the housing. Ensure that the window foil does not wrinkle.

16. Place the collimator with O-ring very carefully on the window, without moving the collimator over the window. The O-ring presses the conducting layer on the housing to ensure good electrical contact.

17. Fit the fixing screws and tighten the screws in opposite corners carefully in steps until all screws are equally tight. This will ensure that pressure is applied evenly to the window.





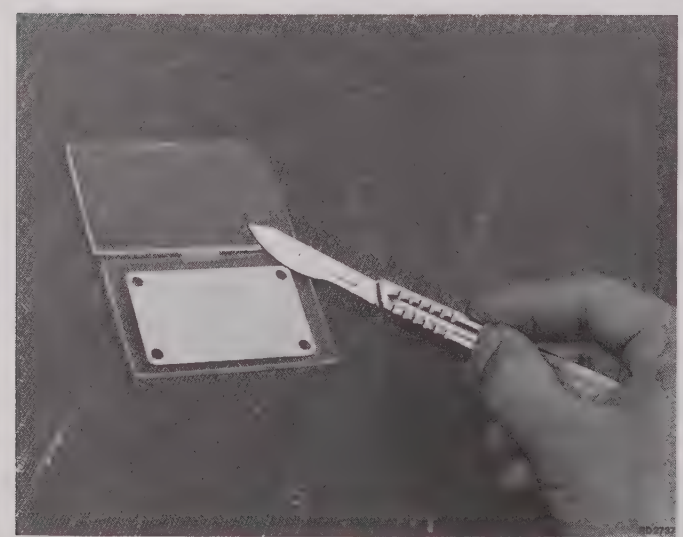


Fig. 5.6.6.3.2. Detector windows.

5.6.6.3.3. Detector anode wire

The anode wire fitted in the flow detector, and that recommended for replacement purposes, is of magno-nickel, with a diameter of 50 μm. It is stretched along the electrical centre-line between two PFTE insulating discs.

If a new anode wire must be fitted, proceed as follows:

1. Cut the existing anode wire and remove the insulating discs.

2. Carefully press out the tapered locking pins and discard them.

3. Clean the flow detector housing, insulating discs, and O-rings with petroleum ether.

CAUTION

Use only petroleum ether for cleaning. Other cleaning agents (e.g. acetone, carbo-tetrachloride, Freon, trichorethylene, etc. must not be used as their residues can alter the characteristics of the detector by polluting the gas. Only a few molecules of pollutant are necessary for this to occur.

4. Select an ordinary sewing needle which will pass through the brass bushes in the centre of the insulating discs.

5. Pass the end of a piece of new anode wire through the eye of the needle, and then clean the anode wire carefully with a cloth damped with petroleum ether.

CAUTION

After cleaning the anode wire, be careful not to touch it with the fingers.

6. Pass the wire through the plain brass bush in the centre of one of the insulating discs and secure it by pressing a new tapered pin into the bush.

7. Pass the wire through the centre of the detector body and then through the threaded brass bush in the centre of the other insulating disc.

8. Hold the detector body with the insulating discs in position and the anode wire vertical, so that the wire is pulled straight by the weight of the needle which will now be hanging below the body. If necessary, add a small weight to the needle (e.g. crocodile clip) to keep the wire straight.

9. Secure the anode wire in the threaded bush with a tapered pin.

10. Cut off the ends of the anode wire protruding from the bushes, together with the protruding tapered pins.

11. The anode wire should now be held straight between the two bushes, Stretch the anode wire very slightly by turning the threaded bush 90^{o} counterclockwise.

5.6.6.4. Remounting

The detector is mounted on a ring that is clamped to the 2θ shaft by means of a split ring and four screws demounted, check that the O-rings and the H.T. contact spring are correctly in position.

The detector is mounted on a ring that is clamped to the 2θ shaft by means of a split ring and fow screws [Fig. 8.2.11 items 140/54] . Do not loosen these screws unless it is necessary to change the relationship between the detector and the shaft. Do not remove the screws completely as replacing the two halves of the split ring will then be difficult.

5.6.6.5. Tests

5.6.6.5.1. Detector resolution and quality factor

An important property of a flow detector is its resolution. Since the number of collisions made as electrons move towards the anode (after the entry of an X-ray photon) is a statistical process, the pulse amplitude from the detector is not a single value, but occurs as a spread of voltages in the shape of a distribution which is approximately Gaussian.

The resolution (R) is expressed in terms of the peak width at half the maximum height (FWHM) expressed as a percentage of the mean pulse height (V):

$$R = \frac{FWHM}{V} = 100\ \% \quad \text{(see Fig. 5.6.6.5.1.)}$$

The mean pulse height is wavelength dependent.
The theoretical resolution for a flow detector is given by:

$$R\% = \frac{8{,}3}{\sqrt{E}} = 0.109\sqrt{\lambda}$$

where λ = the wavelength of the element line.

If the resolution is divided by $\sqrt{\lambda}$ a quality factor Q can be derived. This will be constant for every element line measured with a particular detector.

$$\text{i.e. } Q = \frac{R}{\sqrt{\lambda}} \quad \text{with a countrate of } 4\text{x}10^4 \text{ cps.}$$

Typical values for the Q factor for the flow detector are:

Detector condition	Q factor	Resolution for CuKα
Normal	12	15 %
Requires cleaning	14	> 18 %

If the quality factor (Q) is larger than 14 and if detector resolution is important because of interference effects, the detector must be cleaned and the anode wire renewed, as previously described.

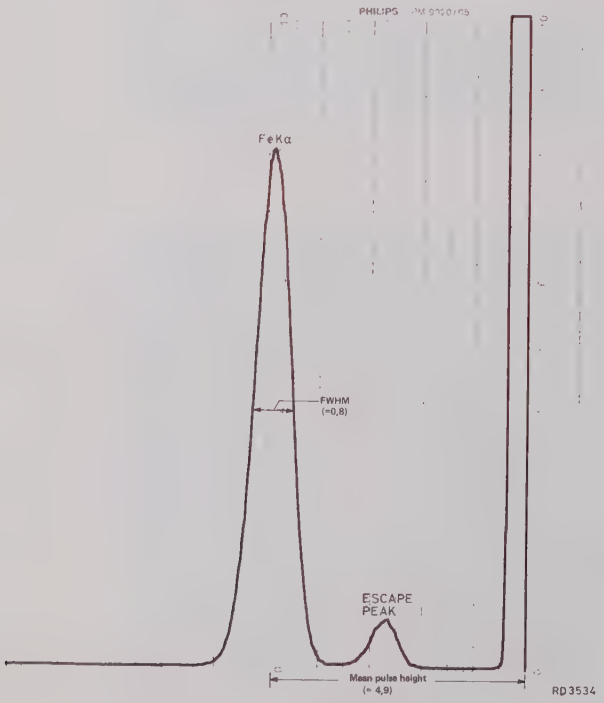


Fig. 5.6.6.5.1. Flow detector resolution

5.6.6.5.2. Window conductivity

The windows used with the flow detector have a very thin metallic coating, but it is possible for them to lose their surface conductivity. This loss of conductivity can have the effect that there is a gradual decrease of intensity during the working day, which can be corrected by realignment or recalibration of measuring channels. By the following day the intensity has returned to normal but again decreases during the working period. This effect is caused by the positive potential which is built up on the window owing to the collection if positive ions, and which is not discharged because the window has become nonconducting. This results in electrons produced by ionization being collected by the window instead of by the anode wire.

Poor conductivity can eb established with the following test, based on measurements made with potassium Kα radiation:

1. Select a sample which is low in potassium and set the appropriate parameters. The sample should produce about 2000 cps, with a chromium X-ray tube using 20 kV and 5 mA. (Use calibrate potentiometer on the X-ray Generator). Display the countrate on the chart recorder.

2. Insert a second sample which is high in potassium.

3. Change the X-ray tube power to 45 kV, 20 mA and increase the detector HT by 300 V.

4. Maintain these conditions for about 2 minutes and then restore the original conditions as quickly as possible (i.e. 20 kV, 5 mA and original detector HT). The chart recorder will record a higher countrate.

5. If the window is conducting satisfactorily the countrate displayed on the chart recorder will return immediately to the original countrate and remain steady.

If the window is defective a lower countrate will be observed, and this will gradually increase to the original value over a period which may vary between a few minutes and some hours depending on the conductivity of the window.

5.6.7. Gas leak sensor [Fig. 8.2.2]

5.6.7.1. Introduction

The gas leak sensor consists of a metal block containing two separate chambers through which the detector gas flows. The gas entering the flow detector passes first through one of the chambers, and the gas leaving the detector passes through the second chamber. In each of the chambers an NTC is fitted; these NTCs form two arms of a bridge circuit and the bridge is adjusted so that it is in balance when the amount of gas flowing into and out of the flow detector is the same. If a leak occurs in the detector (e.g. a ruptured window) such that the difference between gas flowing into and out of the detector is more than 6 litres/hour the bridge will be unbalanced resulting in the gas supply valve Y15 being closed, warning LEDs being lit, and a software error message being generated (see also sections 4.9.3. and Fig. 4.9.1).

5.6.7.2. Demounting

The gas leak sensor is mounted on the crystal chamber [see Fig. 8.2.2) with two screws, and is sealed to it with a silicone rubber compound. After the electrical and gas connections have been removed the sensor should be carefully prised away from the crystal chamber with a knife blade or similar implement.

5.6.7.3. Disassembly

Remove the two screws securing the cover plate and carefully withdraw the cover plate and the NTCs. The cover plate and the NTCs are sealed to the body with 4 O-rings which are retained in position with two aluminium spacing tubes [see Fig. 5.6.7.3.).

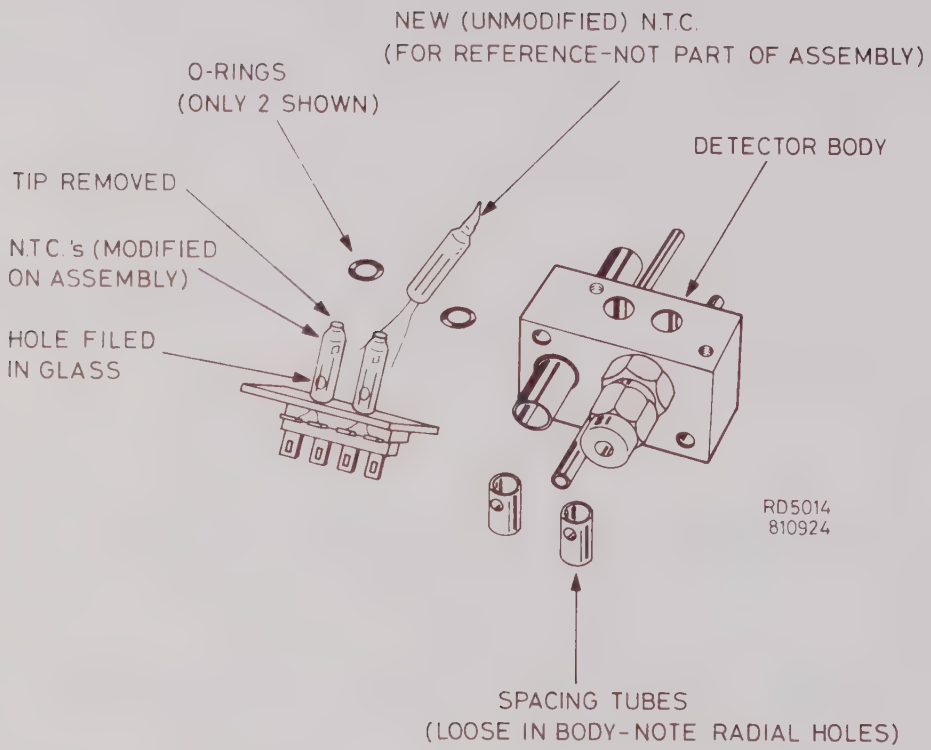


Fig. 5.6.7.3. Gas leak detector

5.6.7.4. Non routine maintenance

5.6.7.4.1. Cleaning

Remove any residues of silicone rubber by carefully rubbing or scraping it away.

Clean all the components with petroleum ether — do not touch any of the components with the hands after cleaning.

CAUTION

Use only petroleum ether for cleaning. Other solvents can leave residues which can pollute the detector gas.
Just a few molecules of pollutant are sufficient to affect the performance of the flow detector.

5.6.7.4.2. Renewal of NTCs

The NTCs are mounted in holes in the cover plate, the connecting wires being passed through the holes and soldered to the connector block. The NTCs are sealed into the detector body by O-rings.

New NTCs are in the form shown in Fig. 5.6.7.3 and must be modified (as also shown in Fig. 5.6.7.3) as follows:

1. Using a suitable needle file, mark a line round the sealed-off end of the NTC and break this end off as shown in the figure.

2. Using a round needle file, make a small hole in the side of the NTC as shown in the figure.

Mount the NTCs in the holes of the cover plate, keeping the connecting wires as short as possible. Solder the wires in position. Ensure that the hole in the side of the NTC is positioned as shown in the figure.

5.6.7.5. Reassembly

After mounting the NTCs, clean the assembly as already described using petroleum ether. Clean also the O-rings and spacers.

Reassemble the components, placing in each large hole in the body first an O-ring and second a spacing tube. Ensure that the hole in the spacing tube is aligned with the appropriate radial hole in the body. Place an O-ring over each of the NTCs and push it up against the cover plate.

CAUTION

Assemble the O-rings dry — do not use grease as this will cause pollution of the detector gas.

5.6.7.6. Remounting

Coat the contact surfaces of the gas leak sensor and the crystal chamber with silicone rubber sealant (Dow Corning Silastic 732 RTV, see chapter 8.6) and remount the sensor while the sealant is still wet. Ensure that the sealant is fully cured before evacuating the spectrometer.

5.6.7.7. Alignment and testing [see Fig. 4.9.1]

1. Using the pressure regulator, check that the gas pressure switch is on at a pressure of > 0.7 atm. and off at a pressure of < 0.55 atm.
   If not, adjust it accordingly (see section 5.6.8).

2. Disconnect the two gas hoses supplying the flow detector from the gas leak sensor inside the crystal chamber. Connect a short length of rubber hose in place of the flow detector, so as to short circuit the leak sensor.

3. Press the "GAS RESET" pushbutton and check that the LED displays "DETECTOR GAS" on the spectrometer front panel and on the miscellaneous control pcb are extinguished. If not:
   a. Check that the gas pressure switch is on.
   b. Check that the gas inlet valve Y15 (GASOK– = 0) is open.
   c. Check that the voltage on the measuring point X2.B is positive with respect to that on X2.A.

4. Using the pressure regulator, reduce the secondary pressure below 0.55 atm. Check that the LED displays "DETECTOR GAS" are illuminated.

5. Set the secondary pressure to 0.7 atm., press the pushbutton "GAS RESET", and adjust the gas flowrate to 1 litre/hour.

6. Simulate a leak in the flow detector of 6 litres/hour by inserting a hypodermic needle in the wall of the rubber short-circuit hose mounted in step 2.

   The hypodermic needle must have a diameter of 0.3 mm and a length of 65 mm. (The diameter is by far the more critical dimension.)

7. Adjust potentiometer R41 [see Fig. 4.9.1] on the Miscellaneous Control pcb until the voltage on the measuring point X2.A is just positive with respect to that on X2.B.

   After 10 seconds the LED displays "DETECTOR GAS" must be illuminated and the valve Y15 must be closed.

8. Withdraw the hypodermic needle. The gas flow must now be zero, and the voltage on X2.B must now be positive with respect to that on X2.A.

9. Insert a new short-circuit tube to ensure that no gas escapes via the hole left by the hypodermic needle.

10. Press the pushbutton "GAS RESET". The gas flow must be restored.

11. Vary the gas flow from 0 to 4 litres/hour and check that the voltage on X2.B remains positive with respect to that on X2.A.

12. Remove the short-circuit tube and reconnect the gas flow detector.

13. Press the pushbutton "GAS RESET" to restore the gas flow.

5.6.8. Vacuum measuring head

5.6.8.1. Introduction

The vacuum measuring head consists of a body containing two NTCs, one of which is evacuated and sealed and the other is open to the vacuum in the spectrometer. The NTCs are cast into the body with an epoxide resin, so that the measuring head cannot be repaired. The head is sealed to the crystal chamber with an O-ring.

5.6.8.2. Cleaning

If cleaning should become necessary, use petroleum ether. Before remounting the measuring head, ensure that the petroleum ether has fully evaporated, especially any which may have entered the open NTC.

5.6.8.3. Alignment and testing [see Fig. 4.9.1]

For circuit adjustment, two power supplies with variable voltage outputs and voltage indication are required.

The vacuum measuring head is factory tested and the voltages which are present on its connector pins for certain vacuum levels are engraved on it.

To adjust the circuit, proceed as follows:

1. Remove the connector X-62 from the vacuum measuring head.

2. Connect a power supply between pin 2 (negative) and pin 3 (positive) set the voltage to be the same as "Ucomp" ("U3" on early models) engraved on the vacuum measuring head.

3. Connect a power supply between pin 2 (negative) and pin 1 (positive). Set the voltage to be the same as "U5" ("U1" on early models) and adjust the potentiometer R11 so that the reading on the vacuum meter is 5 Pascal.

4. Set the voltage between pin 2 and pin 1 to be the same as "U100" ("U2" on early models) and adjust the potentiometer R17 so that the reading on the vacuum meter is 100 Pascal.

5. Repeat the adjustments in steps 3 and 4 until both meter readings are correct. This is necessary because the two adjustments are strongly dependent on each other.

6. Adjust the voltage between pins 2 and 1 so that the meter reads 30 Pascal. Adjust potentiometer R23 until the LEDs V9 and B3 are just extinguished. Check that VACOK+ = 1 is present on connector X-38 pin A17.

7. Disconnect the power supplies and connect the vacuum measuring head.

N.B. 10 Pascal = 0,075 Torr, 30 Pascal = 0,225 Torr.

5.6.8.4. Remounting

Before remounting, ensure that the contact surfaces of the vacuum measuring head and the crystal chamber are clean and undamaged.

Lightly coat the O-ring with vacuum grease, Apiezon L (or M).

5.6.8.5. Operational check

1. Check that with AIR selected the vacuum indication is "ambient".

2. Check that when VACUUM is selected the LEDs vacuum, V9 and B3, are lit, and are extinguished when the vacuum level reaches 30 Pascal.

5.7. GONIOMETER

5.7.1. Introduction [Fig. 8.2.11]

The goniometer is a very high precision gearbox from which all backlash has been eliminated by means of adjustable bearings and torsion springs. The goniometer has an input shaft driven by a stepping motor. This shaft has an integral worm gear which drives a gearwheel on a lay-shaft. Also on this lay-shaft are two further gearwheels which drive two concentric output shafts. The inner shaft has an output angle of 1Θ and the outer shaft an angle of 2θ. The crystal changer is attached to the 1θ shaft and the detectors are attached to the 2θ shaft.

The stepping motor makes 200 steps per resolution, and the gear ratio of the goniometer is such that
1 resolution of the input shaft equals $1^{o}2\theta$.
Thus 1 stepping motor step equals $0.005^{o}2\theta$.

The goniometer must be filled with oil (Shell Tellus 33) to a level of 3/4 of the height of the sight glass. This oil is initially supplied with the spectrometer. Ordering details for further supplies will be found in chapter 8.2.6.

5.7.2. Demounting [see Fig. 8.2.11]

Before demounting the goniometer, the crystal changer, the flange [69], the split rings [140] and the vacuum seals must all be removed.

The goniometer is mounted on a sub-frame which is attached to the base plate of the spectrometer cabinet by bolts which pass through nylon insulating bushes and washers. These nylon parts ensure that the sub-frame and everything mounted on it is insulated from the spectrometer cabinet.

The goniometer is attached to the sub-frame by three bolts inserted from the underside — in order to remove these bolts it is first necessary to remove the whole sub-frame from the cabinet.

CAUTION

The centre line of the goniometer shafts is aligned in the factory with the centre line of the crystal chamber. Do not disturb the screws fixing the goniometer to the sub-frame unless correct realignment can be assured.

5.7.3. Non-routine maintenance

5.7.3.1. Cleaning

The goniometer must be kept clean if wear is to kept to a minimum and angular reproducibility is to be maintained. However, since the goniometer is in an enclosed atmosphere, frequent cleaning should not be required.

Clean the exposed parts of the goniometer with lint-free cloth or a soft brush damped with a solvent such as petroleum ether or alcohol (ethanol).

CAUTION

Do not use acetone or methylated spirits for cleaning.

They can damage parts of the spectrometer.

5.7.3.2. Adjustments

5.7.3.2.1. Microswitches

The microswitches mounted on the goniometer and/or the associated actuating levers attached to the goniometer should be adjusted as follows:

	Microswitch	Switching point
S20	lower end stop	between -0.4 and $-0.5^{o}2\theta$ (display = 999.6 and 999.5)
S22	lower end stop approach	$+1.5^{o}2\theta$
S23	arm decoupling	between $+116 \pm 1$ and $128 \pm 1^{o}2\theta$
S21	upper end stop	$+147.6 \pm 0.2/-0^{o}2\theta$
S24	upper end stop approach	$+146.5 \pm 0.1^{o}2\theta$

The switching points of the microswitches should be adjusted using the single step mode (SSM.100). Approach the lower end stop from a higher angle and the upper end stop from a lower angle when determining the switching points.

NOTE

When either the lower or upper end stop microswitch is actuated the direction of stepping motor rotation will be reversed and the goniometer will drive continuously up and down.
This action can be stopped by typing "/ return".

At the points where the upper and lower end stop microswitches are actuated the goniometer must not be mechanically blocked. Check that at the operating point of the upper end stop microswitch a thin sheet of paper can still be passed between the gas flow detector and the primary collimator.

5.7.3.2.2. Stepping motor

If the displayed goniometer angle does not agree with the true angle (found, for example, by measuring the element line CuKα after installation of the crystal changer) it can be corrected as follows:

1. Note the difference between the true angle and the displayed angle.
2. Using the single step mode (SSM) rotate the stepping motor until the hole in the coupling is in line with the hole in the coupling housing and the screw clamping the coupling to the stepping motor shaft is uppermost.
3. Pass the locking bar (included with the special spectrometer tools) through the holes in the coupling and the housing, and tighten the nuts on the bar to lock the goniometer mechanically [see Fig. 3.15.3].
4. Loosen the screws clamping the coupling to the stepping motor shaft.
5. Using the single step mode add or subtract the difference (whichever is appropriate) between the true angle and the displayed angle.
6. Tighten the screws clamping the coupling to the stepping motor shaft, remove the locking bar, and check that the true angle and the displayed angle are now the same.

If the stepping motor must be demounted from the coupling housing the lower mounting screw can best be removed/replaced using the special hexagon key supplied for adjusting the primary collimator. This key has a long shank which can be passed through a hole in the vertical section of the dividing wall between the upper and lower spectrometer compartments. This hole is in line with the lower mounting screw.

5.7.3.2.3. Torsion springs

The goniometer is provided with two torsion springs (clock springs) which ensure that the 1θ and 2θ shafts are both pre-loaded in the same direction.
This method removes all backlash and helps to ensure good angular reproducibility.

With the goniometer in its central position ($74^{o}2\theta$) the torsion springs must exert the following forces:

1θ spring [Fig. 8.2.11 item 117]	3 kgfcm (8.8 Nm) ± 5 %
2θ spring [Fig. 8.2.11. item 136]	14 kgfcm (13.7 Nm) ± 5 %

These forces can best be measured with a calibrated spring balance. If necessary the force can be adjusted by winding up the spring and setting the hooked end of the spring over the most suitable of the pins provided. Check that all the windings of the springs are free from each other (i.e. not stuck together).

5.7.3.2.4. Sin θ potentiometer

The sin θ potentiometer can be adjusted as follows:

1. Select crystal TLAP. If this crystal is not fitted set the crystal attenuator jumpers (on p.c.b. Spectrometer control 1) for TLAP for one of the crystal changer positions (preferably a position in which no crystal is fitted), and select this crystal position.

2. Select 1st order and attenuation switch position 1.

3. Select a goniometer angle of $0^{o}2\theta$ (SLF0).

4. Using a digital voltmeter, measure the voltage between X2 pin AC12 and the signal zero (X21). This voltage must be positive with respect to the zero but must be less than +4 mV.

If this voltage is not correct, adjust the sin θ potentiometer by uncoupling it from the 1θ shaft of the goniometer and rotating the potentiometer shaft until the correct voltage is obtained.

5. Select a goniometer angle of $60^{o}2\theta$ (SLF60).
   The voltage measured between X2 pin AC12 and X21 must be +2.8 ± 100 mV, positive with respect to the measuring zero.

5.7.4. Lubrication

Fill the goniometer worm house with oil. Shell Tellus 33 (4822 390 10048) to a level of 3/4 of the height of the sight glass.

Lightly grease the gearwheels and clock springs with Shell Tellus 33 or Shell Macoma 69.

5.7.5. Remounting

The goniometer must be remounted on the subframe so that the centreline of the 1θ and 2θ shafts coincides with the centre line of the crystal chamber.

Recentring is best achieved by clamping a bar (locally made) with a dial gauge attached to its end, to the 2θ shaft, so that the actuating point of the dial gauge bears on the machined surface (inner diameter) of the crystal chamber. When the goniometer is turned through the whole of its range ($0\text{-}147^{o}2\theta$) the dial gauge must not indicate a variation of more than 0.005 mm.

Centring the 1θ and 2θ shafts in the entry hole of the crystal chamber is also important to ensure a good vacuum seal. This is best done by making a special ring which fits the entry hole and the 2θ shaft exactly and which can be placed in position while the goniometer is being mounted and aligned.

5.7.6. 1θ and 2θ shaft vacuum seals

The 1θ and 2θ shafts are sealed to the crystal chamber with an assembly which consists of PTFE (Teflon) rings, O-rings, and steel mounting rings [see Fig. 5.7.6].

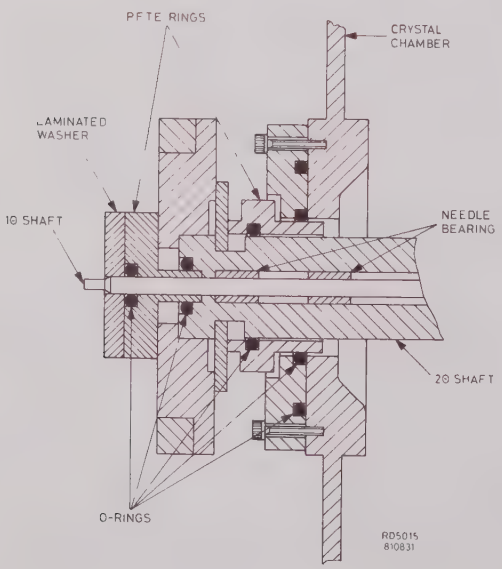


Fig. 5.7.6. 1θ and 2θ shaft seals.

5.7.7. Laminated washer

The laminated washer retains the O-ring which seals the 1θ shaft, and its thickness depends on the relative positions of the goniometer and crystal chamber on the subframe.

To determine the thickness of the laminated washer fit the crystal changer on the 1θ shaft without the washer being present. Press the crystal changer against the shoulder on the 1θ shaft and measure the distance between the frame of the crystal changer and the PTFE sealing ring.
Peel layers from the laminated washer until its thickness is between 0,05 and 0,1 mm less than the measured distance.

This process ensures that the vacuum seal will be effective when the washer is mounted between the PTFE ring and the crystal changer.

5.8. DETECTOR ARM

5.8.1. Introduction

The detector arm, which provides the support for the scintillation detector, is mounted on a bearing on the goniometer 2θ shaft outside the crystal chamber.
At angles below $116^{o}2\theta$ the arm is coupled with the 2θ shaft and moves with it. Between about 116^{o} and $128^{o}2\theta$ the arm is completely uncoupled and remains stationary while the 2θ shaft, carrying the gas flow detector, continues to turn up to the maximum angle of about $148^{o}2\theta$.

The detector arm is carefully balanced in the factory with a lead counter weight to reduce wear and to achieve good angular reproducibility.

An adjustment screw is provided to enable the angular relationship between the scintillation detector and the gas flow detector to be adjusted.

5.8.2. Demounting

With the goniometer demounted from the subframe, the detector arm can be removed from the 2θ shaft of the goniometer after the tab-washer [Fig. 8.2.12 item 39] has been bent straight and the castellated nut [38] has been loosened.

5.8.3. Non-routine maintenance

5.8.3.1. Cleaning

The arm can be cleaned using petroleum ether or alcohol (ethanol). If the wire ball bearing requires cleaning the preferred method is to immerse the arm in an ultrasonic cleaning bath containing Freon. If such a bath is not available, immerse the lower end of the arm in petroleum ether and rotate the bearing by hand to clean it as much as possible.

CAUTION

The screws [Fig. 8.2.12 items 36 and 37] are adjusted in the factory. Do not loosen them unless the bearing is to be renewed, and then only if the special tools required for the renewal procedure are available.

5.8.3.2. Assembly of new wire ball bearings

1. Ensure that all parts are clean.

2. Place the ring [24] on a table and place the arm [27] over it. Place paper or small wood strips under the arm so that the bearing grooves in the ring and in the arm are both at the same height.

3. Fit one of the larger wire rings in the bottom of the groove in the arm and one of the smaller rings in the groove in the ring. If the rings are too large they must be cut so that they are exactly the correct size. There must be no gap between the cut ends, the ends must be cut square, and all burrs must be carefully removed.

4. The bearing consists of 54 balls, 27 of 6.0 mm diameter and 27 of 0.25 inch (6.35 mm) diameter. Insert the balls of the two different sizes alternately.

   CAUTION

   The balls for one bearing are supplied in a package and have been carefully graded for size. Do not mix the balls from one package with those from another, and do not remove the balls from the package until they are to be used.

5. Place the remaining wire rings in the groove.

6. Fit the pressure ring [42] using six screws [37] and washers [34] in alternate holes and tighten them with the fingers only, ensuring that the pressure ring is centrally placed. Use Loctite 222 on the threads of the screws.

7. Insert the remaining six screws [36] with the disc springs [35] and plain washers [34] using Locktite 222 on the threads. Position two disc springs immediately under the head of each screw so that they face in opposite directions with their raised centre sections outwards [see Fig. 8.2.12]. Tighten these screws so that the disc springs are just in contact.

8. Lubricate the bearing with five drops of Shell Macoma 69 applied with a needle or thin piece of wire.

CAUTION

Five drops of foil is sufficient. Do not overlubricate.

9. Tighten each screw [36] once through 45° in the order shown in Fig. 5.8.3.2.

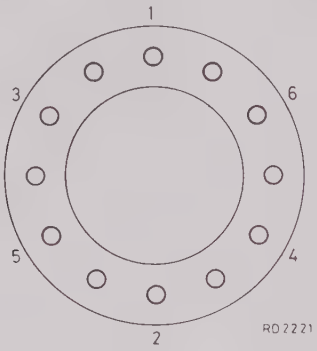


Fig. 5.8.3.2. Screw adjustment order

10. Repeat the procedure in step 9 so that each screw has now been tightened through a total of 90°. Do not adjust the screws [37].

11. Rotate the bearing slowly through at least 10 revolutions in order to run the bearing in.

12. Repeat steps 9, 10 and 11, to complete the running in of the bearing.

13. Loosen one screw [36] and tighten it again until the disc springs are just in contact. Now tighten this screw by 90° only.

14. Repeat this process for all the screws [36] in turn in the order shown in Fig. 5.8.3.2.

15. Tighten the screws [37] firmly with the fingers — do not use tools.

16. Lock the screws [37] with the grub screws [23].

17. Check that the bearing rotates easily and smoothly.

5.8.4. Remounting

Place the arm at the correct angle on the 2θ shaft of the goniometer and tighten the castellated nut [38] so that the arm is clamped firmly on the shaft.
The nut should be tightened using a torque spanner set to 98.1 Nm ± 20 % (1000 kgfcm ± 20 %). If necessary, a small amount of oil may be used between the castellated nut and the tab washer.
Check that the detector arm does not move on the shaft when a torque of 49 Nm (500 kgfcm) is applied to it.
Bend one of the tabs on the tab washer [39] into a corresponding slot in the castellated nut [38] so that the nut cannot become loose.

5.8.5. Measuring data

1. Uncoupling/coupling reproducibility

The difference in angle caused by uncoupling the detector arm and recoupling it must not be greater than $0{,}003^{o}$ 2θ as measured with the test procedure given in section 7.5.11.

2. Pawl moment

The moment PXa necessary to cause the pawl [Fig. 8.2.12 item 3] to be uncoupled must not be greater than 0.49 Nm (5 kgfcm).

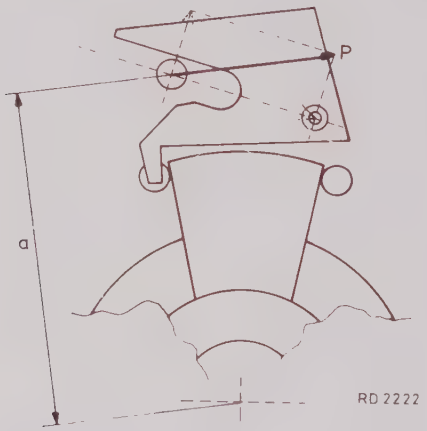


Fig. 5.8.5.2. Pawl moment

3. Uncoupling moment

The moment QXL necessary to cause the detector arm to become uncoupled must be greater than 3.43 Nm (35 kgfcm).

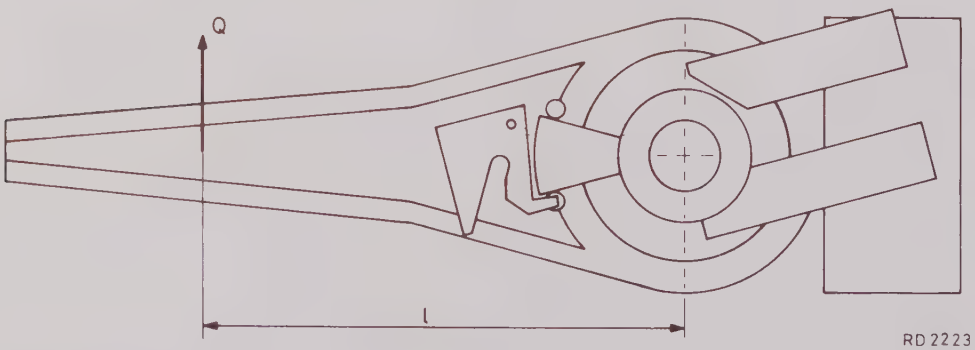


Fig. 5.8.5.3. Uncoupling moment

5.8.6. Alignment of detector arm

Final alignment of the detector arm is made with X-rays on to ensure that there is no angular difference between the scintillation detector and the gas flow detector. The alignment is best made using CuKα radiation ($45.03^{o}2\theta$) as follows:

1. Check that the gas flow detector is correctly aligned using the calibration procedure (CAN CU).
2. Loosen the two clamping bolts [Fig. 8.2.12 item 10].
3. Adjust the screw [17] until the countrate from the scintillation detector is a maximum at the same angle which was found for CuKα with the gas flow detector.
4. Retighten the clamping bolts [10].

5.8.7. Alignment of auxiliary collimator

If the auxiliary collimator is fitted, align it by means of the grub screw [49] in the mounting block.

The alignment must also be made with X-rays on.

5.9. CRYSTAL CHANGER DRIVE MECHANISM [Fig. 8.2.3]

5.9.1. Introduction

The crystal changer drive mechanism is mounted on the crystal chamber cover. The drive mechanism has a 24 Volt synchronous motor connected so that it can rotate both clockwise and counterclockwise.
The motor and its associated gearbox are fixed to a mounting plate, to the back of which are attached six microswitches, one for each crystal position. The drive mechanism ends in a lever on which is a ball bearing which engages in a slot of the maltese-cross disc of the crystal changer. The lever of the drive mechanism makes one revolution to rotate the crystal changer from one position to the next (i.e. six revolutions for one revolution of the crystal changer).

The microswitches are also used to select the appropriate value of attenuator resistance associated with the selected crystal position.

NOTE

If measurements must be made with X-rays on and the crystal chamber cover removed, ensure that the mechanism remains electrically connected to the spectrometer system. For this purpose a long connecting cable is provided.

5.9.2. Demounting

The cover is attached to the crystal chamber with three screws. When demounting the cover observe the following points:

1. Select an 'AIR' atmosphere in the spectrometer, and a goniometer angle of about $70^{o}2\theta$.
2. Support the cover with one hand when removing the fixing screws, to prevent it falling.
3. Remove the cover carefully. The operating lever of the drive mechanism may become hooked behind the connecting hoses of the gas flow detector.
4. Take care that the O-ring sealing the cover to the chamber does not become dirty or damaged.

CAUTION

Do not place the crystal chamber cover on the base plate of the spectrometer. Damage can result if the goniometer inadvertantly is driven to its zero position.

5.9.3. Non-routine maintenance

5.9.3.1. Cleaning

Clean the mechanism using lint-free cloth and petroleum ether. Alcohol is not recommended because the water it contains can become trapped in the seals; this can result in long pumping times before an adequate vacuum level is achieved after reassembly.

5.9.3.2. Reassembly, alignment and testing

The boss [18] is pinned to the output shaft of the gearbox [26], and the gearwheel [10] is pinned to the shaft [6]. New service parts are supplied undrilled and must therefore be drilled and pinned on assembly. Drill a new hole 2 mm diamter and use a new spring dowel.

Lightly coat the quadring [3] with Molykote 44.

The bearing block [4] is sealed to the cover plate [14]. Ensure that these parts are thoroughly clean and coat the sealing surfaces with silicone rubber sealing compound Silastic clear. Assemble the parts while the compound is still wet.

The pinion on the motor shaft is secured with adhesive. If the pinion must be refixed to the shaft, clean the parts carefully and secure the pinion with Loctite 601. Allow the adhesive three hours to cure before using the motor.

The pinion can be removed from the motor shaft if necessary by first heating it gently and subsequently pulling it off.

Alignment consists of adjusting the operating points of the microswitches and positioning the lever [36] on the shaft [6] so that when the cover is fitted to the crystal chamber, the bearing [38] engages correctly with the maltese cross mechanism on the crystal changer, as shown in Fig. 5.9.3.2. Position the lever so that when the mechanism is in the rest position the lever is vertical (i.e. not engaged in the disc of the maltese cross mechanism).

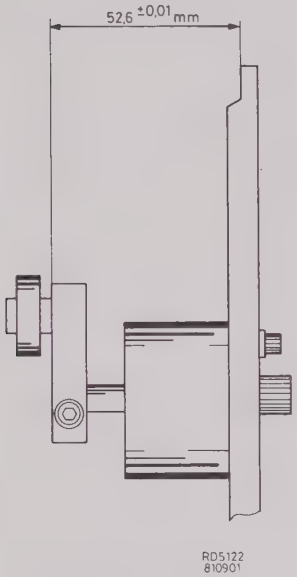


Fig. 5.9.3.2. Operating lever position.

5.9.3.3. Function test

Select each crystal position in turn and check:

1. That the operating lever makes one complete revolution between each selected crystal position.
2. That the mechanism comes to rest in each selected position with the operating lever vertical.
3. That the mechanism rotates in both directions (i.e. with crystal position 1 selected (XTL 1), the selection of positions 2 and 6 causes the mechanism to rotate in opposite directions.
4. That in each rest position the appropriate microswitch is actuated.

5.9.4. Remounting

Before remounting the crystal chamber cover, check that the number of the crystal shown on the spectrometer front panel display represents the crystal which is uppermost on the crystal changer.

Ensure that the O-ring sealing the cover is clean and that it fits properly and is not trapped between the metal-to-metal surfaces of the cover and the crystal chamber.

5.10. CRYSTAL CHANGER [Fig. 8.2.5]

5.10.1. Introduction

The crystal changer provides a means whereby any one of six prealigned analysing crystals may be selected.

The mechanism consists of two main parts — a frame on which the maltese cross mechanism is mounted, and a hexagonal rotatable block on which all the other components are mounted.

On the block six crystal holder assemblies are mounted. Each of these assemblies can be tilted about a shaft, and its position can be adjusted by means of a screw [40] which pushes against a lever [38], causing the assembly to tilt against the pressure of a compression spring [66].

The analysing crystal is retained in the crystal holder assembly by a leaf spring [58].

Two plastic strip sections [63] are fitted to the upper edges of each assembly to reduce the effect of radiation reflected from the crystal holder.

5.10.2. Demounting

The crystal changer is clamped to the 1θ shaft of the goniometer by a screw [76]. The crystal changer can be withdrawn from the shaft once the screw has been loosened.

> **CAUTION**
>
> **Demount the crystal changer with the greatest care. Do not touch the surface of the crystals, which are very delicate and cannot be cleaned with any degree of certainty.**

5.10.3. Non-routine maintenance

5.10.3.1. Cleaning

The preferred method of cleaning is to immerse the entire crystal changer (after removal of the crystals) in an ultrasonc cleaning bath containing Freon. Where this is not possible, immerse the crystal changer in clean petroleum ether and scrub it carefully with a small nylon brush. Check that no hairs from the bush remain trapped in the mechanism after cleaning.

The use of alcohol is not recommended since the water it contains may become trapped in bearings etc. and may considerably lengthen the pumping time required to obtain a good vacuum level.

Do not use acetone or methyated spirits for cleaning — they can cause damage to some parts of the spectrometer.

5.10.3.2. Maintenance procedure

Several points are of importance for the maintenance of the crystal changer:

1. The antiscatter strips [63] may become degraded after a period of use. Remove them be sliding them off the crystal holder. New strips may require cutting to length. Ensure that the strips do not project more than 0.3 mm beyond the end of the crystal holder at the end opposite to the detent disc [36].

2. The spring [57 or 58] must exert a pressure of between 500 and 600 g when depressed from 4 mm to 3 mm.

3. The tension spring [3] is supplied in lengths of 1 metre.
   Approximately 25 mm is required; the effective length must be adjusted by means of the spring hook plates [2] until it exerts a pull of 1000 ± 100 g. This should result in the ball bearing [5] exerting a pressure of 500 ± 50 g against the detent disc [36].

4. The shaft [77] is held in the bearing blocks [10] by spring strips. Between these strips and the shaft a PTFE bearing strip is fitted.

The end of the shaft [77] nearest the detent disc [36] is held with one spring strip [79]. The combined pressure of this strip and the tension spring [3] must be about 800 g.

The end of the shaft [77] furthest from the detent disc [36] is held with three spring strips [79], which must exert a pressure on the bearing block of about 1000 g.

5. Coat the ends of the shaft [77], the PTFE bearing strips [78] and the bearing blocks [10] with Molykote Microfine powder before assembly.

6. When mounting the shaft [77] in the bearing blocks [10] hold down the ends of the spring strips and insert the pins [9]. Do not bend the strips to insert them under previously fitted pins.

7. Set the crystal holder parallel to the shaft [77] within $\pm 0.2^{o}$. The pressure exerted by the spring [66] when the crystal holder is tilted through 2^{o} from this position against the action of the spring must be at least 650 g.

8. The gearwheel [37], the detent disc [36] and the hexagonal block [67] are fixed together with adhesive. If it is necessary to renew any of these parts, ensure that any parts not being renewed are thoroughly cleaned to remove old adhesive.

   The parts should be refixed with Loctite 242 and the adhesive should be left to cure fully before use.

9. The screw [45] should be secured with Loctite 242.

5.10.3.3. Lubrication

The following parts should be sparingly lubricated with Shell Tellus 33 after cleaning:
1. Detent lever axis pin [85].
2. Crystal holder axis pins [64].
3. Actuating lever axis pins [47].
4. Locking peg [43].

The actuating screws [40] should be lightly coated with Molykote Microfine powder.

5.10.4. Remounting

1. Check that no mechanical blocking of the goniometer, detector arm, or flow detector can occur.

2. Switch on the spectrometer — the goniometer will run down to 0^{o}.

3. Fit the crystal changer carefully on the 1θ shaft, align the uppermost crystal with the flow detector and the primary collimator, and clamp the changer to the shaft. Check before mounting the changer that the laminated washer is present on the 1θ shaft.

4. Complete the alignment of the system as given in section 3.

5.10.5. Reproducibility check

Check the reproducibility of the crystal changer using the method given in Section 7.

5.10.6. Transportation

If the crystal changer must be transported, it is essential that the transport clamp originally supplied with it be refitted before packing. The clamp must be placed so as to secure the shaft on the side opposite to the detent disc.

> CAUTION
>
> **Unless the transport clamp is fitted, serious damage is likely to result when the crystal changer is transported.**

The crystal changer is a delicate, high precision assembly. Ensure that it is adequately protected by substantial packaging during transportation.

5.11. PRIMARY COLLIMATOR [Fig. 8.2.9]

5.11.1. Introduction

The purpose of the primary collimator is to ensure that fluorescent radiation from the sample strikes the analysing crystal in an approximately parallel beam at the correct angle, and that radiation at other angles is excluded

The collimator is constructed of a number of specially coated thin metal blades separated by spacers and mounted in a masive metal body. The collimator is divided into two sections:
a. fine collimator - blade spacing 150 μm.
b. coarse collimator - blade spacing 550 μm.
The two sections are assembled so that either the fine or coarse sections can be selected for use. The section not in use is covered by a lead radiation shield. Selection of the collimator is made with a compressed-air-operated drive mechanism.

The collimator blades are held in position in the body under spring pressure. This kind of construction ensures that accurate blade spacing is maintained, and that the blades do not become distorted with changes in temperature.

The collimator body has gear teeth cut around its periphery, which, in use, are engaged with a bevel gear which is part of the drive mechanism. Rotation of the drive mechanism causes the collimator to be rotated in a bearing which is an integral part of the collimator assembly. The bearing consists of a housing formed from two rings between which a wire ball bearing is mounted.
This bearing is very accurately adjusted and must not be readjusted in any way unless adequate facilities are available.

WARNING

It is dangerous to operate the spectrometer if the lead radiation shield is not fitted to the collimator.

5.11.2. Demounting

The primary collimator is mounted in a hole in the adjoining walls of the crystal chamber and the sample chamber. It must be removed from the sample chamber side (i.e. from above).
To demount it proceed as follows:

1. Open the sample chamber and demount the sample turret, the X-ray tube, the mask holder and the aluminium filter [see Fig. 3.6.4].

2. Open the crystal chamber. Remove the four screws which attach the two semicircular clamping rings round the collimator on the crystal chamber side. These two semicircular rings carry the mechanical end stops for the primary collimator [see Fig. 5.11.5].

3. Carefully lift out the collimator from the sample chamber side (i.e. from above).

CAUTION

Do not loosen any of the screws around the collimator on the sample chamber side (i.e. the upper side). This can result in the collimator bearing being disassembled (4 screws) or in the sample chamber becoming detached from the crystal chamber (4 screws). Either of these occurrences will cause serious misalignment of the spectrometer.

5.11.3. Disassembly

To disassemble the collimator bearing, remove the four screws securing the clamping ring to the pressure ring.

CAUTION

1. **Do not disassemble the bearing unless proper workshop facilities and mechanically skilled personnel are available.**
2. **Do not loosen the screws which fix the two parts of the collimator body together. Reassembly can only be done in the factory.**

It is advisable to disassemble the collimator bearing in a box or tray to avoid losing any of the balls.

5.11.4. Non-routine maintenance

5.11.4.1. Cleaning

The preferred method for cleaning the primary collimator is to immerse it in an ultrasonic cleaning bath containing Freon. If this facility is not available, immerse the collimator in clean petroleum ether. Rotate the collimator in clean petroleum ether. Rotate the collimator in its bearing to clean it as much as possible.
If necessary scrub the outside surfaces with a nylon brush, afterwards checking that no hairs from the brush remain trapped in the bearing or between the collimator blades.

If the blades have become clogged (e.g. from a broken pressed powder sample), it may be possible to clean the collimator without demounting it from the spectrometer. First demount the crystal changer and place a suitable receptacle inside the crystal chamber.
Pour clean petroleum ether through the collimator, catching it in the receptacle. Afterwards carefully blow compressed air through the collimator to remove all residues.

The use of alcohol for cleaning is not recommended because the water it contains becomes trapped in bearings and seals. This can result in very long pumping times before a satisfactory vacuum can be obtained.

CAUTION

Do not use acetone, methylated spirits, or similar solvents for cleaning.
These will destroy the coating on the collimator blades and make the collimator useless.

After cleaning, check that the collimator rotates freely and smoothly in its bearing.

Lubricate the bearing with three drops of Shell Macoma 69 or Shell Tellus 33 applied 120° apart with a needle. Do not overlubricate — three drops of oil are sufficient.

5.11.4.2. Wire ball bearing

Renewal of the wire ball bearing can only be undertaken by a skilled machine fitter or service engineer using precision workshop facilities. In the absence of these, a defective collimator should be renewed as a complete assembly.

For renewal of the wire ball bearing the following items of workshop equipment must be available:

. One marking out table or surface plate of tool making quality

. One dial gauge capable of measuring to an accuracy of 0.001 mm. It must have a bracket enabling it to be attached by a screw to the end of the collimator bearing housing.

. Two gauge blocks 93.000 mm thick.

. One vertical reference block to the dimensions shown in figure 5.11.4.2.

. One torque screwdriver capable of registering at least 16 kg cm.

. One torque gauge with a bracket enabling it to be attached by screws to the collimator bearing housing and capable of registering at least 1000 g cm.

. One support block as shown in figure 5.11.4.3. for use during initial assembly.

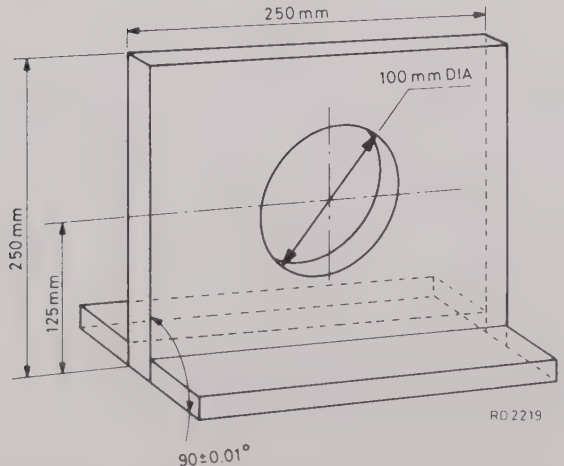


Fig. 5.11.4.2. Vertical reference block

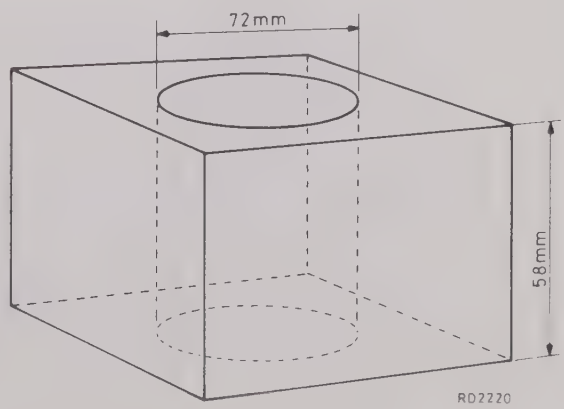


Fig. 5.11.4.3. Support block

The balls and wire rings from which the bearing is assembled are supplied in a package as a matched set. Do not mix the balls from one package with those from another package, and do not remove the contents from the package until they are required for assembly.

The collimator, bearing housing, and pressure ring should be carefully cleaned. It is recommended that cotton or nylon gloves be worn during the assembly procedure to ensure that no finger marks are left on the components which will later be required to operate in vacuum.

5.11.4.2.1. Assembly of new bearing

1. Coat the wire rings with Molykote Mikrofine powder (see Chapter 8.6). The coating must not exceed 6 g/m^2. This can be judged by the colour, which should be silver/grey. Apply the powder firmly using a small piece of chamois leather or similar material and clean off any excess with petroleum ether. The object is to apply a coating only one or two microns in thickness.

   CAUTION

   Ensure that all excess Molykote powder is removed. Loose powder will contaminate the analysing crystals.

2. Place one of the smaller wire rings in the groove round the collimator on the side of the groove nearest the gear teeth.

3. Place one of the larger rings in the groove in the bearing housing [5].

   NOTE

   It may be necessary to cut the wire rings to ensure a good fit. If so, the ends must be cut square and there must be no appreciable gap between the cut ends.

4. Place the block (Figure 5.11.4.3) on a flat surface and lower the collimator into the hole in the block, with the toothed end downwards.

5. Lower the bearing housing [5] over the collimator so that it rests on the block. It must be placed so that the cut ends of the rings are 180^{o} apart.

6. Lightly coat the balls with Shell Macoma 69.

7. The balls are of two different sizes. Insert the larger and smaller balls alternately in the groove until the groove is filled. There should be 30 balls of each size.

8. Insert the remaining wire rings, ensuring that the cut ends are displaced 180^{o} apart and 90^{o} from the cut ends of the lower rings.

9. Assemble the pressure ring [7] turning the screws and washers [12] until they are finger tight. Insert the grub screws [8] until their ends are level with the base of the pressure ring.

5.11.4.2.2. Forming of bearing wires

1. Attach the torque gauge to the bearing housing [5].

2. Carefully tighten the screws in turn [12] with the torque screwdriver, a little at a time, keeping the torque value on all the screws approximately equal. During this operation rotate the bearing. Continue tightening the screws until the torque required to turn the collimator in the bearing housing is between 800 and 1000 gcm. Continue to turn the collimator for a short time to work form the bearing wires.

3. Slacken the screws [12] until they all exert an equal pressure and the torque required to turn the collimator in the bearing housing is between 300 and 350 g cm.

4. Check that the collimator rotates freely and smoothly in the bearing housing.

5. Tighten the grub screws [8] until they are firmly in contact with the surface of the bearing housing [5].

6. Tighten the screws [12] until the torque on each is equal and a minimum of 16 kg cm.

7. Check that the torque required to turn the collimator in the bearing housing is still between 300 and 350 g cm.

8. Remove the torque gauge.

5.11.4.2.3. Tolerance check

1. Place the vertical block [see Figure 5.11.4.2] on the marking-out table, pass the collimator and bearing through the hole in the block, and rest the collimator on the two gauge blocks. The gauge blocks must be positioned so that they are under the flat areas machined across the periphery at each end of the collimator.

2. Attach the dial gauge to the bearing housing and adjust it so that it registers 0.000 mm when the actuating point just touches the surface of the vertical reference block.

3. Keeping the collimator stationary on the gauge blocks, carefully rotate the bearing housing through 180° from top vertical to bottom vertical positions. The difference between the highest and the lowest readings of the dial gauge must not exceed 0.035 mm.

4. Secure the screws [8] and [12] with Loctite 222.

5.11.4.2.4. Final assembly

1. Fit the lead shield [14] with the screw and washers [13].

2. Check that the aperture in the lead shield is set so that the edge nearest the centre of the collimator is 0.5 ± 0.1 mm. above the centreline of the collimator.

3. Secure the screws [13] with Loctite 222.

5.11.5. Remounting

1. Note the selected position for the collimator (C or F), indicated on the spectrometer front panel display.

2. Loosen the screws clamping the bevel gear to the shaft of the drive mechanism and press the bevel gear towards the bearing bush in the wall of the crystal chamber so that it will not be engaged with the collimator.

3. Place the collimator in position, remount the semicircular clamping rings, but do not do up the fixing screws too tightly. Set the end stop adjustment screws (in the semicircular rings) so that they are approximately at the centre point of their travel.

4. Insert the X-ray tube. Rotate the collimator with its semicircular clamping rings until the collimator blades are aligned with the edge of the X-ray tube and the peg in the collimator is in contact with the appropriate end stop [see Fig. 5.11.5).

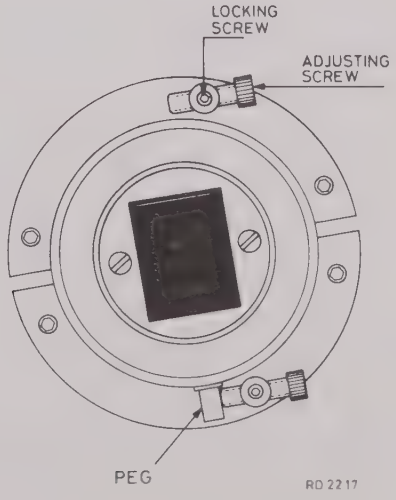


Fig. 5.11.5. Primary collimator end stop adjustment. (view from underside, in crystal chamber)

5. Tighten the clamping screws so that the collimator is firmly fixed in position. Check that the collimator blades are still parallel to the edge of the X-ray tube. The blades must also be parallel to the opening in the lead shield on the collimator.

6. Rotate the collimator by hand so that the other half is selected. Check that the blades are parallel to the edge of the X-ray tube and to the opening in the lead shield. If necessary adjust the end stop screw to achieve this.

7. Rotate the collimator to the position selected by the collimator drive mechanism, engage the bevel gear, and check that the appropriate microswitch on the drive mechanism is just actuated, and clamp the bevel gear to the shaft so that when the drive mechanism is operated the collimator will be firmly pressed against the mechanical end stops under spring pressure.

8. Select fine and coarse collimator and check that the collimator comes firmly (but not too hard) against both end stops.

9. If the crystal changer has been demounted, remount it and align the LiF200 crystal, using X-rays.

10. Insert a copper sample and select 30 kV 10 mA.

    WARNING

    X-rays are now present in the crystal chamber, which is open. Follow the following adjustment procedure carefully.
    Use the special hexagon key provided, and do not put the hands in the crystal chamber.
    Do not leave the generator on for longer than is essential.

11. Select each collimator (CO LC and COL F) in turn and adjust the associated end stop screw with the special hexagon key until a maximum countrate is achieved.

12. Switch off the generator.

13. Lock the adjusting screws with the grub screws.

14. Align the rest of the crystals if necessary.

5.12. PRIMARY COLLIMATOR DRIVE MECHANISM [Fig. 8.2.2]

5.12.1. Introduction

The primary collimator drive mechanism consists of a double-acting compressed-air actuator, a gear train and lever mechanism to translate the linear movement of the actuator into rotary movement to drive the collimator, and an oil-filled shock absorber which ensures that the collimator is driven firmly but not too hard against its mechanical end stops.

5.12.2. Demounting

The mechanism is attached by two screws to the collimator drive vacuum sealing bush and by two screws to the goniometer sub-frame.
When these screws are removed the mechanism can be demounted.

Before demounting, mark the mating teeth of the gearwheels with a felt-tip marker. This will aid in correct remounting.

5.12.3. Non-routine maintenance

5.12.3.1. Cleaning

The assembly can be cleaned with petroleum ether or alcohol.

5.12.3.2. Lubrication

Before reassembly lightly coat both plain bearings with Molykote BR2.

5.12.4. Remounting

When remounting the assembly, set the actuator in the correct position (for coarse or fine collimator) and ensure that the gearwheels are correctly meshed according to the marks made on the wheels before disassembly.

5.12.5. Adjustments

1. Check that the collimator is driven firmly and smoothly but not too hard against its end stops.
   The pressure exerted by the spring, as measured at the end stop pin on the collimator, must be 8-10 Newtons.

2. Over the working area there must be positive backlash present between the gearwheels when the gearwheel is pressed inwards.

3. The shock absorber must become effective $10^{o} - 15^{o}$ before each of the mechanical end stops is reached. The points at which it becomes effective are determined by the position of the upper two rings [89] attached to the shaft [93].

4. The lower two rings on the shock absorber shaft (one at each end of the cylinder) should be adjusted so that when the collimator is against its end stops the clearance between the appropriate ring and the cylinder is 1-3 mm.

5. The last 5 mm of the movement of the mechanism before each of the collimator mechanical end stops is reached should take approximately 0,5 second. This time can be adjusted with the needle valve [96].

6. The microswitches S26 and S27 must be actuated just before the mechanical end stops are reached. The operating points can be adjusted with the cams [19] fixed to the shaft [13];

5.12.6. Checks

1. After adjustment check that the collimator rotates smoothly in both directions and is not driven too hard against its mechanical end stops.

2. Check that when the collimator is rotated in both directions not too many air bubbles are present in the transparent tube of the shock absorber. There may be no more than two bubbles with a diameter of 2-5 mm and no more than five bubbles with a diameter of 1 mm.

3. Check that there is no oil leakage from the shock absorber. There may be a coating of oil on the shaft but there must be no drops of oil present.

4. Check, that when each collimator is selected, the correct microswitch is operated – this can normally be seen by a change – the letters "F" and "C" on the front panel display.

5.12. 7. Shock absorber

The shock absorber consists of a cylinder with a double-acting piston. The ends of the cylinder are connected together by a transparent tube, and the whole assembly (cylinder and tube) are filled with a light oil (Shell Tellus 22) under vacuum, to ensure that no air bubbles remain in the oil. As the piston is moved in the cylinder, the oil is pumped from one end to the other via the transparent tube.
The upper cylinder connection contains an adjustable restriction so that the resistance to the movement of the oil can be adjusted.

A leakage of oil resulting in air entering the assembly indicates the failure of one of the seals. Since refilling under vacuum is a difficult process, a leaking assembly should be renewed.

5.13. TRANSPARENT CRYSTAL CHAMBER COVER [Fig. 8.2.4.]

5.13.1. Introduction

The transparent crystal chamber cover enables the crystals to be adjusted in a vacuum. It does not have a pin for operating the safety circuit microswitch, so when it is in use the microswitch must be overridden with the special tool provided.

5.13.2. Non-routine maintenance

5.13.2.1. Cleaning

Clean the cover and the O-ring and quadring with petroleum ether or alcohol (ethanol).

5.13.2.2. Lubrication

Lightly coat the O-ring [7] with vacuum grease Apiezon L.
Lightly coat the O-ring [9] and the quadring [6] with vacuum grease Molykote 44.

5.13.2.3. Adjustment

Fix the position of the lever [19] so that when the knob [16] is rotated the bearing [23] engages correctly in the maltese cross mechanism on the crystal changer [see also Fig. 5.9.3.2].

5.14. CAP UNIT MECHANISM [Fig. 8.2.10]

5.14.1. Introduction

The cap unit consists of a base plate on which the cap and its associated compressed-air actuator are mounted. The cap and actuator are fixed to a shaft so that the cap can be moved through approximately 90°. Attached to the shaft is a lever and two cams which actuate microswitches in the two end positions of the cap movement.

Also mounted on the cap unit are the airlock filter and two valves Y12 (airlock vacuum inlet) and Y13 (airlock air inlet). A pipe coupling, sealed with a blanking plug, is provided for the connection of the helium system for flushing the airlock.

5.14.2. Demounting

The cap unit is attached to the sample chamber cover with four screws. Before it can be removed the electrical connector, the vacuum/helium hoses, and the compressed air connections (bayonet type) must be detached.

Demount the cap unit by carefully raising it at the front upper edge and lifting it off towards the back of the spectrometer (see also Fig. 3.6.2).

NOTE

The cap unit is connected to the airlock by a short vacuum hose which must also be detached.

5.14.3. Disassembly

For safety reasons the following features are incorporated:

1. The cap is permanently attached to the lever which carries it by a blank-headed pin which is a press-fit in the cap. For additional security the pin fixed with adhesive.

2. The lever carring the cap is attached to the operating shaft by two screws which can only be removed if the whole cap unit mechanism is disassembled.

5.14.4. Non-routine maintenance

5.14.4.1. Cleaning

For cleaning, use lint free cloth and petroleum ether or alcohol (ethanol).

CAUTION

Do not use solvents such as acetone, methylated spirit or methyl ethyl Ketone for cleaning. These can damage the paint finish.

5.14.4.2. Lubrication

The compressed-air acutator is lubricated for life.
The O-ring should be lightly coated with vacuum grease Apiezon L or M.

5.14.4.3. Alignment

Adjust the length of the actuator shaft with the screwed linkage [Fig. 8.2.10 item 38] and nut [39] so that when the cap is down (spectrometer airlock opening closed), the angle between the operating lever [30] and the vertical is approximately 20°.

5.14.5. Remounting

The cap unit should be remounted in the opposite way used for demounting. Ensure that the hole in the mounting plate fits around the raised boss on the sample chamber cover.

CAUTION

Ensure, when remounting the cap unit, that the lead shield is first replaced over the sample chamber, and that the microswitch S40 [Fig. 8.2.6] is operated correctly.
It is easy to displace the actuating lever of this microswitch when the lead shield is replaced.

5.14.6. Operational check

Check that:

1. When the cap is raised, it does not strike the rear wall of the loading position.

2. When the cap is closed, it is pressed firmly against the sealing surface of the sample chamber cover. This is especially important when a helium system is fitted, to avoid loss of helium during airlock flushing.

3. When the spectrometer is in use, an adequate vacuum level is achieved.

4. When the cap is lowered, it moves smoothly and firmly, without striking the sealing surface of the sample chamber too hard. This can be judged from the way the cap closes — it must close firmly on the O-ring, but must not strike the surface so hard that a metal-to-metal contact occurs. If necessary, adjust position of the end piece [38] on the screwed actuator shaft, or of the lever [30] on the shaft [29].

5. When the cap is raised, it moves smoothly and does not tend to strike the plastic moulding at the back of the sample entry area. This is also affected by the adjustments described under point 4.

6. When the cap is in the open and closed positions, the appropriate microswitches are actuated. The actuating arm for the microswitches associated with the closed position [5] is fixed to the shaft [29] with a spring dowel [7]. The microswitches associated with the open position are operated by two cams [14] which are clamped to the shaft [29] with grub screws [13]. The operating points of these microswitches are related to the cap adjustments described in point 4, so that after a mechanical adjustment has been made, it may be necessary to adjust the positions of the cams.

WARNING

The adjustment of the microswitches S18 and S19 is critical for radiation safety. Ensure that these microswitches are deactuated when the cap is raised by the smallest possible amount.
The maximum permitted gap between the front of the cap and the upper surface of the loading opening before the microswitches are deactuated is 1.5 mm.

5.15. SAMPLE CHAMBER COVER

5.15.1. Introduction

The sample chamber cover is an important element in the airlock. The upper surface forms part of a seal with the O-ring on the cap and the underside contains an O-ring and release springs.

WARNING

A boss is mounted in the centre of the underside of the cover. This is important for the reduction of scattered radiation, and must not be removed.

The upper surface of the cover contains a lead disc for radiation protection. This must not be removed.

5.15.2. Demounting

The cover is fixed in position with six screws.
Loosen the screws successively on opposite sides of the cover, so as to keep the pressure as even as possible during removal.

5.15.3. Non-routine maintenance

5.15.3.1. Cleaning

Clean with a lint-free cloth damped with alcohol (ethanol) or petroleum ether.

5.15.3.2. Release springs

Three small release springs are placed around the underside of the fill opening. These ensure that the airlock ring in the sample turret is separated from the O-ring on the underside of the sample chamber cover when the plunger is lowered in the spectrometer.

5.15.3.3. O-rings

Coat the O-rings lightly with vacuum grease Apiezon L or M.

5.15.4. Remounting

Place the cover in position so that the locating pin in the sample chamber fits the hole in the cover.

CAUTION

When replacing the cover be careful not to damage the safety microswitch on the side of the sample chamber. Check that the microswitch is correctly operated by the edge of the cover.

Fasten the cover by carefully and gradually tightening the screws opposite to each other in the order shown in Fig. 5.15.4. Each screw should be tightened a little at a time.

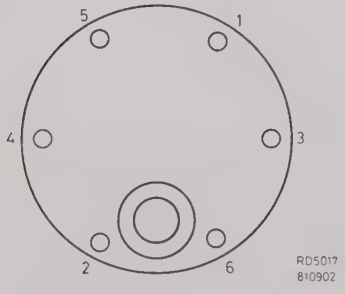


Fig. 5.15.4. Order for tightening screws.

5.15.5. Operational check

Check that an acceptable vacuum level is achieved, and that when the plunger is lowered, the airlock ring is correctly released.

5.16. SAMPLE TURRET [Fig. 8.2.7]

5.16.1. Introduction

The sample turret is a disc with four rotatable sample positions. In each of these positions, a ring is mounted by means of six sealed ball bearings — three mounted vertically and three horizontally.

In each of these rings a loose ring is fitted.
This loose ring rests on the upper surface of the bearing ring on three set screws. By means of these set screws the rings are critically adjusted in the factory to a high degree of precision for both height and parallelism.

> **CAUTION**
>
> **Each loose ring [6] is precision adjusted for its individual position in the sample turret. The rings and the turret are numbered (1 to 4). Do not interchange the rings as this will affect the reproducibility of analytical measurements.**

The bearing rings have a gear ring attached.
When the turret is fitted in the spectrometer, all four rings are in mesh with an idler gear which is driven by the spinner motor. Thus, when the spinner is running all four samples are rotated simultaneously.

A lead/steel 'Y' form radiation shield is mounted on top of the sample turret.
The height of this shield is adjusted in the factory so that a minimum possible clearance exists between the upper surface of this shield and the lower surface of the sample chamber cover, when the sample turret is rotated. This radiation shield ensures that scattered radiation cannot leave the spectrometer via the airlock opening.

> **WARNING**
>
> **Always check that the 'Y' form radiation shield is present on the sample turret before the sample chamber cover is remounted. Failure to do this can result in radiation leakage.**

5.16.2. Demounting

The sample turret rests on three ball bearings in the sample chamber. It is held firmly against these bearings by a compression spring fitted between the drive arm [Fig. 8.2.6 item 135] and the turret.
First loosen the screw [137], remove the screw [136] and lift off the drive arm and spring. Carefully lift out the sample turret.

> **CAUTION**
>
> **Be careful not to drop the loose rings in the sample turret.**

5.16.3. Non-routine maintenance

5.16.3.1. Cleaning

The sample turret should be cleaned without disturbing the adjustment of the bearing rings, since these cannot be successfully aligned unless precision workshop facilities are available.

1. Remove the loose carrier rings [14] and clean them using petroleum ether.

   > **CAUTION**
   > **Do not disturb the adjusting screws [8, 11, 12] because realignment will then be necessary.**

2. Clean the sample turret using a lint-free cloth and petroleum ether. Do not immerse the turret in the solvent, and avoid getting the solvent into the bearings.

3. Check that the bearings rotate freely. Replace worn or stiff bearings.

4. The adjustable carrier rings are numbered. Reassemble the carrier rings in the turret, ensuring that each ring is placed in the position with the corresponding number.

5.16.3.2. Renewal of bearings [Fig. 8.2.7]

In each sample position a bearing ring is supported by six precision ball bearings. If these bearings become worn or damaged it may be possible to renew them without subsequent adjustment if this is done carefully. To obtain access to the bearings remove the gearwheel [20] which is attached to the bearing [7] with screws.

CAUTION

Do not disturb the adjusting screws [8 and 11].

After renewing any bearing, check the reproducibility of the sample turret as explained in section 7.5.5. If the reproducibility requirements are not met, the sample turret must be adjusted.

5.16.3.3. Bearing adjustment

This adjustment procedure can only be carried out by a skilled technician with access to good mechanical workship facilities. If these are not available, do not attempt adjustment, but return the sample turret the factory using the repair procedure.

For the adjustment procedure the following items of workshop equipment must be available:
. One marking-out table or surface plate of tool making quality.
. Three gauge blocks 25,000 mm thick (other dimensions are not important).
. One gauge block 45,000 mm thick (for use as a height reference).
. One dial height gauge capable of measuring to an accuracy of at least 0.001 mm.

Mount the bearing carrier rings [14] in the turret and adjust them as follows:

1. Support the turret under its outer edges on three 25,000 mm gauge blocks, spaced approximately 120° apart and resting on the marking-out table [see Fig. 5.16.3.3].

2. Adjust the bearing carrier rings with the screws [11] so that:
   a. the upper surface, measured at the height of the three vertical bearings, is parallel with the lower surface resting on the gauge blocks within 0.01 mm.
   b. the height of the upper surfaces is as small as possible in relation to the surface resting on the gauge blocks.
   c. the screws [8] are tightened so that the spring washers [9] are not quite fully compressed.

3. Lock the screws [8 and 11] with a suitable locking paint.

4. Assemble the bearing rings [7], the spacer rings [19] and the gear rings [2].

5.16.3.4. Sample carrier ring adjustment

1. Insert the sample carrier rings [6] in the bearing rings with the corresponding numbers engraved adjacent to them on the turret plate.

2. Place the 45,000 mm gauge block and the dial height gauge on the making-out table or surface plate and adjust the height of the gauge until it reads 0.000 when just touching the gauge block.

3. With the height gauge check the height of the carrier ring in position 1 at four points 90° apart on its upper surface. Adjust the set screws [5] until all four readings are within 0 ± 0.007 mm.

4. Calculate the average of the last four readings made after final adjustment of the ring in position 1.

5. Adjust the other three carrier rings until they all lie within a tolerance band 0.015 mm wide, using the average height of carrier ring 1 as the zero reference.

6. Place the dial gauge over one point on the upper surface of each carrier ring and rotate the ring whilst preventing the bearing ring from rotating. The gauge must not register a variation of more than 0.010 mm over one revolution.

7. Secure the set screws [5] with a suitable locking paint.

5.16.3.5. Lubrication

The sample turret bearings are of a precision sealed type and should not be lubricated. If they do not rotate smoothly and freely, they should be renewed.

5.16.4. Remounting

1. Replace the sample turret in the spectrometer, gently lowering it over the central shaft. Check that the sample turret rotates freely on the three supporting bearings (i.e. that the gear rings are fully engaged with the spinner gearwheel).

2. Place the compression spring and the drive arm on the shaft, ensuring that the peg in the drive arm is engaged in the slot in the sample turret.
   Insert the screw and washer in the end of the drive shaft and tighten it completely to compress the spring.

3. Rotate the turret until one of the sample positions is situated directly over the plunger.

4. Tighten the clamping screw in the drive arm.

5. Rotate the turret by hand, check that the drive mechanism stops in the detent positions and that in these detent positions the sample positions come to rest centrally over the plunger.

5.16.5. Reproducibility test

Check the reproducibility of the sample turret as explained in section 7.5.5. If the reproducibility requirements are not met, the adjustments must be repeated until they are.

5.17. SAMPLE TURRET DRIVE MECHANISM [Fig. 8.2.8]

5.17.1. Introduction

The sample turret drive consists basically of a maltese cross mechanism driven by a synchronous motor, M3, and a reduction gearbox. This combination has a ratio of 25:1.
A detent mechanism is provided to determine the four loading/measuring positions of the sample turret and five microswitches to determine the positions of the sample turret and the motor.

5.17.2. Demounting

The mounting plate of the mechanism is attached by four screws to the underside of the crystal chamber and the drive shaft is coupled to the shaft carrying the sample turret by a spring disc.
The mounting plate also carries a bracket with four connectors. This bracket must also be removed before the mechanism can be demounted.

5.17.3. Disassembly

The boss holding the maltese cross disc is fixed to the shaft [1] with a spring dowel [34].
This dowel must be pressed out before the boss can be removed.

5.17.4. Non-routine maintenance

5.17.4.1. Cleaning

The mechanism can be safely cleaned with petroleum ether. Do not allow petroleum ether to enter the bearings or the gearbox.

5.17.4.2. Lubrication

No lubrication of this mechanism is required. If the bearings do not turn smoothly and evenly, they should be renewed.

5.17.5. Remounting

During remounting, ensure that the drive shaft and the shaft on which the sample turret is mounted are in line and that when the mechanism is rotated the coupling is not stressed.

> **CAUTION**
>
> **Do not rotate the mechanism by turning the lever on the generator shaft. This can damage the gearbox. Always rotate the mechanism by the maltese cross disc or by the sample turret.**

Check that the mechanism turns smoothly and that the ball bearings on the drive arm run evenly in the slots in the maltese cross disc. The disc must have no tendency to move in the direction opposite to its normal direction of rotation when the ball bearing enters or leaves the slot.

Check that the microswitches S1 (Plunger interlock) S2 (motor in rest position) and S3, 4 (turret position decoding) are correctly operated. S3 and S4 are actuated by the cam [27] which is positioned on the shaft by two set screws.

5.18. PLUNGER MECHANISM [Fig. 8.2.6]

5.18.1. Introduction

The plunger mechanism consists of a double-acting compressed-air actuator with an adjustable platform on its upper end. This platform raises and lowers the sample holder in the spectrometer loading position and forms, together with the loose ring in the sample turret, the lower seal of the airlock.

An electromagnetic valve Y14 is mounted in the lower compressed-air inlet. This valve is part of the plunger/cap electronic interlock circuit, and is open when signal PLUEV~ is applied (i.e. PLVEN+ = 1).

A collar on the lower end of the plunger shaft actuates five microswitches.

S11 Safety circuit 2 (in parallel with S19 on the cap unit)

S12 Safety circuit 1 (in parallel with S18 on the cap unit)

S13 In series with sample turret drive motor

S14 Plunger high (PLUH1—)

S15 Plunger low (PLULO—)

5.18.2. Demounting

The plunger mechanism is surrounded by a radiation shield which is secured by two nuts (see Fig. 5.18.2.a). Before the plunger mechanism can be demounted, this shield must be removed. Proceed as follows:

1. Remove the securing nuts [see Fig. 5.18.2.a].

2. Press the shield downwards and then tilt it and pull it forward as shown in Fig. 5.18.2.b.

   WARNING

   The radiation shield is a close fit around the plunger mechanism. This can make it difficult to remove and replace. Do not reduce the size of this shield nor bend it in any way, as this can result in radiation leakage.

3. Disconnect the compressed air hoses.

4. Demount the three brackets carrying the microswitches. Keep the washers in a safe place — they are essential for correct remounting.

   It is not necessary to disconnect any of the wiring unless a microswitch must be renewed.

   Be careful not to alter the adjustment of any of the microswitches.

5. Withdraw the four fixing screws [see Fig. 5.18.2c] with which the plunger mechanism is attached to the sample chamber.

6. Withdraw the plunger mechanism from the sample chamber.

5.18.3. Disassembly

1. Detach the plate [Fig. 8.2.6, item 203] which supports the electromagnetic valve Y14. Leave the valve in position.

   CAUTION

   The compressed air connections to Y14 are sealed with an adhesive. Be careful not to break the seals. If the connections must be resealed, clean the screw threads, coat them with Loctite 542, and assemble the parts whilst the adhesive is still wet.

2. Using a micrometer or vernier gauge, measure accurately the position of the microswitch operating cam [165] in relation to the end of the shaft [177]. Note the measurement for future use.

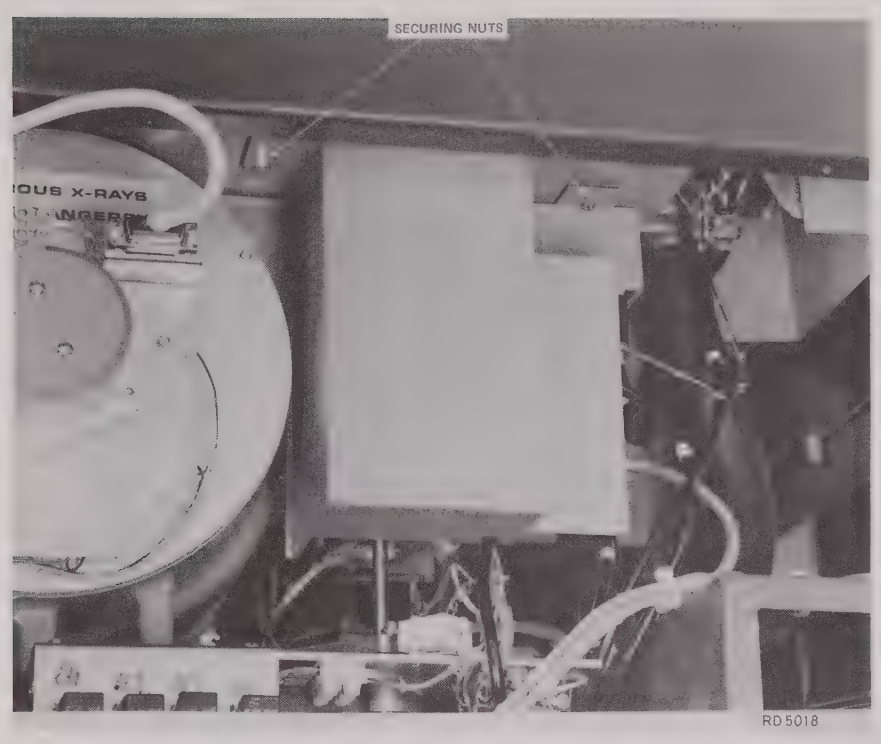


Fig. 5.18.2.a. Plunger mechanism radiation shield.

Fig. 5.18.2.b. Removing the radiation shield.

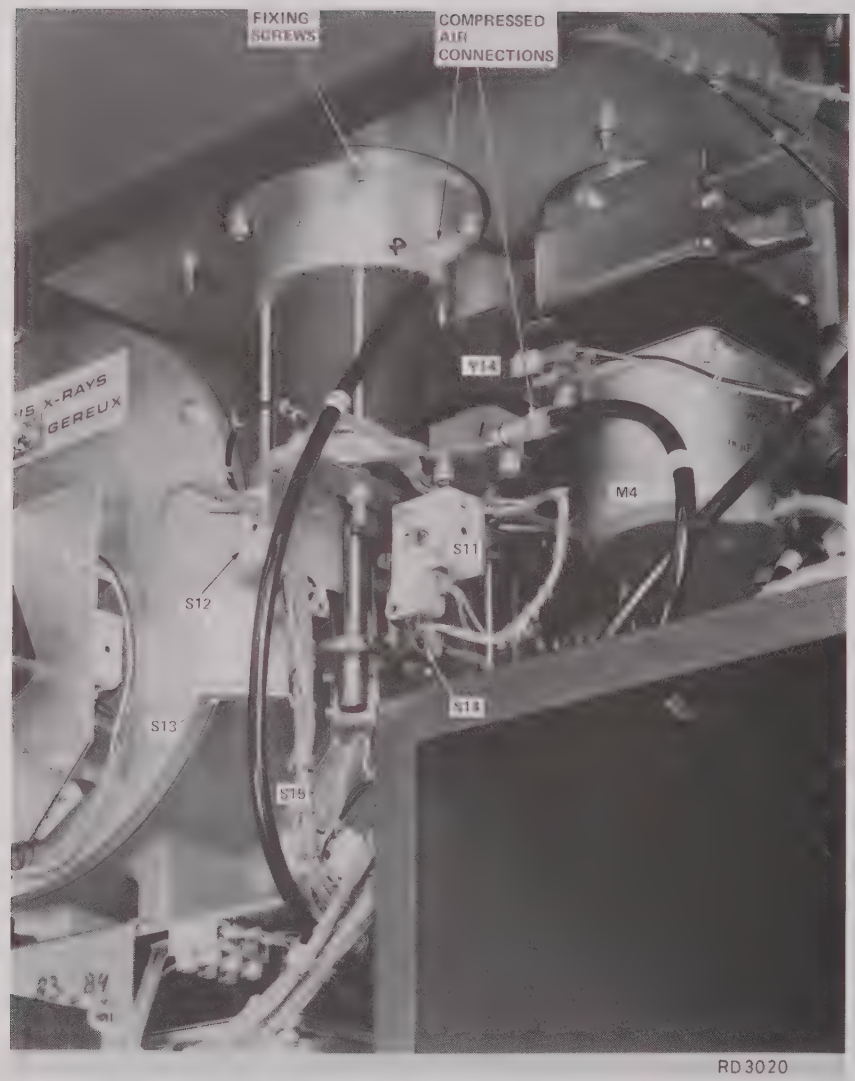


Fig 5.1.8.2.c. Plunger and spinner mechanisms.

3. Remove the cam [165].

4. Remove the remaining nuts [159] and withdraw the plunger end cap [169].

5. Remove the nut [190] which secures the sealing platform [187] to the shaft [177].

6. Withdraw the shaft [177] with the piston [174] from the plunger body.

NOTE

The piston is attached to the shaft with a spring dowel. It will not normally be necessary to detach the piston from the shaft.

7. Remove all O-rings and quad-rings and the teflon support rings. The teflon ring [180] on the inside of the housing [184] is retained with a circlip [179].

NOTE

In the first production series the circlip used was plain and is rather difficult to remove. Subsitute a circlip of the current type which can be removed and replaced with circlip pliers.

5.18.4. Non-routine maintenance

5.18.4.1. Cleaning

Clean all the components carefully using a lint-free cloth and petroleum ether or alcohol (ethanol). Check that no foreign matter remains in the plunger mechanism.

5.18.4.2. Lubrication

Coat all the quad-rings, the inside surface of the tube [173] and the shaft [177] with Molykote 44.

Coat all the static O-rings and grooves with Apiezon L or M.

5.18.5. Reassembly

Reassemble the components in the reverse order to that used for disassembly, taking note of the following points:

1. Ensure that the two plain washers [6] are placed under those nuts [159] which are not used to fasten the valve mounting plate [203]. Do not use washers under the nuts used to fasten the valve mounting plate. This ensures that the outer surfaces of all four fixing nuts are at the same height, permitting correct positioning of the brackets holding the microswitches.

   Tighten all four nuts to an equal torque value.

2. Position the microswitch operating cam [165] on the shaft [177] using a micrometer or vernier gauge at the distance from the end of the shaft previously measured at 5.18.3-2.

5.18.6. Remounting

1. Remount the plunger mechanism, tightening the screws opposite to one another round the flange until all are equally tight.

2. Remount the brackets carrying the microswitches.
   Check that the microswitches are correctly actuated at the end positions of the plunger.

3. Reconnect the compressed air hoses and the electrical wiring to the electromagnetic valve Y14.

4. Remount the radiation shield, taking care that the wiring harness fits in the cut-out in the bottom of the shield.

5.18.7. Operational check

1. Using the commands SLP and SMP check the correct operation of the airlock.

2. Check that an acceptable vacuum level is reached within one or two hours.

5.19. SPINNER MECHANISM [Fig. 8.2.6.]

5.19.1. Introduction

The spinner mechanism consists of a synchronous motor (M4) and a gearbox which drives a shaft via an eccentric coupling. The shaft passes through a rotary vacuum seal and turns a gearwheel attached to the upper end of the shaft.

5.19.2. Demounting

1. Detach the gearwheel [110].

2. Remove the lead shielding around the plunger and spinner mechanisms (see Fig. 5.18.2.a and 5.18.2.b).

3. Demount the spinner motor and gearbox together with the mounting bracket [83]. These should be left screwed together and can be laid on the spectrometer horizontal separation panel without disconnecting the electrical wiring. For this purpose loosen the two side screws [84] and remove the screw [84] in the cross-piece of the mounting bracket.

4. Remove the three screws [96] which attach the housing [95] to the sample chamber.

5. The sealing block [95] is sealed to the sample chamber with a silicone rubber compound. Carefully press or tap it out from above.

6. Note the position of the excentric drive lever [88] on the shaft [94], and detach the lever.

5.19.3. Disassembly

Disassemble the spinner components. The quad-ring is held in position by a disc [99] which is retained by two screws; a support ring is fitted between the quad-ring and the sealing disc.

5.19.4. Non-routine maintenance

5.19.4.1. Cleaning

Remove the silicone rubber compound adhering to the housing [95] and to the sample chamber [109] by carefully scraping it away with a suitable implement. There is no suitable solvent which can be used to remove the silicone rubber compound.

Clean all the components with petroleum ether or alcohol (ethanol). Do not allow the cleaning solvent to enter the ball bearings.

5.19.4.2. Lubrication

Coat the quad-ring, the shaft, and the housing where they contact the quad-ring, with Molykote 44.

Do not lubricate the ball bearings; if they do not run easily and smoothly, they should be renewed.

5.19.5. Reassembly

Reassemble the components in the reverse order to that in which they were disassembled. Ensure that the teflon support ring [98] is placed between the quad-ring and the disc [99].

5.19.6. Remounting

Coat the sealing surfaces of the housing [95] and the sample chamber with Dow Corning Silastic 732 RTV clear sealant, and remount the spinner while the sealant is still wet.

5.19.7. Operational check

Check the operation of the spinner using the appropriate test commands.

5.20. MASK MECHANISM [Fig. 8.2.6]

5.20.1. Introduction

The mask mechanism consists of a compressed-air actuator operating a two-position mask holder via a rotary vacuum seal and a right-angled bevel gear drive.

NOTE
If the filter mechanism is also to be demounted, it is advisable to do this immediately after the mask mechanism has been demounted.

5.20.2. Demounting

1. Remove the mask holder [30].
2. Remove the packing strip [41].
3. Remove the actuating lever [63]. Be careful not to move the position of the nut [64] on the actuator shaft.
4. Remove the drive arm with springs [56].
5. Remove the bracket [50] together with the actuator.
6. Withdraw the housing [47].

5.20.3. Disassembly

1. Press out the pin [34] holding the bevel gear [35] to the shaft [49], and remove the bevel gear.
2. Withdraw the shaft [49].

NOTE
The plain bearing [48] is fasted in position with an adhesive/sealer.

5.20.4. Non-routine maintenance

5.20.4.1. Cleaning

Clean all the components with petroleum ether or alcohol (ethanol).

5.20.4.2. Lubrication

Coat the O-ring [44], the housing, the shaft, and the plain-bearing as appropriate with Molykote 44.
Coat the O-ring [32] with vacuum grease Apiezon L or M.

5.20.5. Reassembly

Reassemble the components in the reverse order to that in which they were disassembled. Be careful to ensure that the O-ring [44], the support ring [43], and the two wavy washers [36] are assembled in the correct order.

5.20.6. Remounting

Remount the assembly. Check that the ball bearing [60] runs correctly between the leaf springs [55]. In the end positions the leaf springs should be bent between 1 and 2 mm.

5.20.7. Alignment

The mechanical end stops for the masks are provided by two screws. Check that the masks are in the centre of the primary collimator when the appropriate screw is in contact with the sample chamber. Adjust the screws if necessary.

Check that the screws are not bent. If necessary renew them with hardened machine screws.

5.20.8. Operational check

1. Using the test commands, check that the mask movement is correct and that the mask comes firmly against each of the end stops.

2. Check that in the end positions, the microswitches S46 (MASK2) and S28 (MASK1) are actuated. This can be seen on the spectrometer front panel display.

3. Check the reproducibility of the masks using the test described in chapter 7.

5.21. FILTER MECHANISM [Fig. 8.2.6.]

5.21.1. Introduction

The filter mechanism consists of a compressed air actuator driving a shaft via an eccentric coupling. The mechanism is spring loaded to return to the "filter in" position whenever power to the spectrometer is switched off. This last is necessary to prevent damage to the aluminium filter during removal and insertion of the X-ray tube. The drive shaft is sealed to the sample chamber by a quadring. The upper end of the shaft carries a boss to which the filter is fitted.

5.21.2. Demounting

1. Remove the filter and the boss.

2. If the only requirement is to renew the quadring, this ring can now be removed without demounting the mechanism further.

   CAUTION

   Removing the quadring at this stage involves the use of a suitable implement, which will probably damage the quadring. Be careful not to scratch the sealing surfaces of the sample chamber and shaft during removal of the quadring.

3. Remove the cam [104] from the end of the shaft.

4. Remove the microswitch S28 from the collimator drive mechanism [Fig. 8.2.2 item 39].

5. Remove the two screws [17] holding the mounting bracket [68].

6. Loosen the screw [5] which fastens the operating lever [56] to the shaft [115].

7. Remove the mounting bracket [68], at the same time sliding the operating lever [56] downwards along the shaft.

8. Withdraw the shaft [115] from below.

5.21.3. Non-routine maintenance

5.21.3.1. Cleaning

Clean all the components with petroleum ether or alcohol (ethanol).

5.21.3.2. Lubrication

Coat the quadring and the shaft with Molykote 44 grease.

5.21.4. Remounting

Remount the components in the reverse order to that in which they were demounted.

Ensure that the quadring is properly fitted in the space between the shaft and the sample chamber. This requires the quadring to be pressed into the space with a suitable tool. Be careful not to damage the quadring, or the vacuum sealing surfaces of the shaft and sample chamber.

Fit the boss [112] on the shaft so that it retains the quadring in its groove.

5.21.5. Alignment

1. Fix the position of the cam [104] on the shaft so that it correctly operates the two microswitches S25 (FILSD– = 0) and S45 (FILNS– = 0) when the compressed air actuator is extended by hand.

2. Fix the filter to the boss so that in the "in" position it fully covers the window of the X-ray tube. The distance between the filter and the tube should be 0 – 0,5 mm.

5.21.6. Operational check

1. Using test commands, check that the filter mechanism is driven firmly against its mechanical end stops. In these positions the leaf springs on the drive lever should be bent about 1 to 2 mm.

2. Check that in the end positions the microswitches are correctly operated, by observing the FILTER display LED on the spectrometer front panel.

3. Using the test procedure described in chapter 7, check the reproducibility of the filter.

5.22. X-RAY TUBE ENTRY [Fig. 8.2.6]

5.22.1. Introduction

The entry point for the X-ray tube provides a vacuum seal for the tube. In addition, it is provided with a thermal isolating ring to reduce the effect of anode heating/cooling on the rest of the spectrometer.

The entry point is also protected by a microswitch which forms part of the spectrometer safety circuit. This ensures that the X-ray tube is fully inserted before X-rays can be generated.

5.22.2. Cleaning

Clean the sample chamber, O-ring, isolating ring, and X-ray tube sealing surface with petroleum ether.

5.22.3. Lubrication

Coat the O-ring with Apiezon L or M.

5.22.4. Microswitch

Check that the microswitch operating lever moves freely, and that the microswitch is adjusted so that it is actuated only when the X-ray tube is fully inserted.

5.23. EQUIPMENT REQUIRED FOR ELECTRICAL ADJUSTMENTS AND CHECKS

- Universal meter with high impedance input
- Oscilloscope
- Frequency standard
- Recorder PM 8203
- Two power supplies – 0-6 volts.

5.24. INTRODUCTION TO ELECTRICAL ADJUSTMENTS AND CHECKS

Never insert or remove a printed circuit board from the spectrometer while power is switched on.

CAUTION

The Miscellaneous Control and the Safety Display PCBs are connected to the standby power supply. If either of these PCBs must be removed or replaced the generator must be disconnected from the mains.

5.25. EARTH RESISTANCE

The resistance between the system earth terminal in the X-ray generator and any metal part in the system must be less than or equal to 0,1 ohm.

5.26. TEMPERATURE STABILIZATION SYSTEM

The voltage applied to the valves Y16 and Y17 in the cooling water circuit must be 24 V +/–1 V. The ripple voltage must be less than or equal to 100 mV.

5.27. DETECTOR HIGH VOLTAGE SUPPLIES

1. Demount the protective cover from the detector supply panel A59.

WARNING

High voltage will be present on some components when the cover is removed.

Measure the voltage on the detector supply panel between the following pins as appropriate:
X59 pins 15 (–) and 17 (+) HV1 (1500 V)
X59 pins 10 (–) and 9 (+) HV2 (3000 V)

2. Set the potentiometer HV1 to 1000 V. The measured voltage must be 1000 V +/–5 %.

3. Set the potentiometer HV2 to 2000 V. The measured voltage must be 2000 V +/– 5 %.

If the measured voltages are not within the required tolerances remove the potentiometer dials, adjust them to the appropriate values, and remount them on the potentiometer shafts.

4. Set the potentiometer HV1 to 1100 V and HV2 to 1600 V and measure the ripple voltage when both supplies are fully loaded. This must be less than or equal to 5 mV.

5.28. COMPRESSED AIR/SAFETY DISPLAY

1. Check that the AIR PRESSURE LED on the safety display is extinguished when the air pressure is reduced to 2,5 +/– 0.1 atmosphere.

2. Check that the over pressure valve operates when the input pressure is raised to 4,5 atmosphere. If necessary adjust the valve to achieve this.

5.29. VOLTAGE CONTROL DISPLAY

The following voltages, measured with a high impedance universal meter, should be as follows:

24 V	: +/–20 %
–56 V	: +/–30 %
180 V	: +/–30 %
All other voltages	: +/–10 %

The current between the relevant soldering pins (with the exception of the –56 V and the 180 V supplies) must be 100 mA +/–20 %.

5.30. SPECTROMETER CONTROL 1 [Fig. 4.6.2]

1. Jumpers

The following jumpers must be closed:

W65	: address selection
W70	: address selection
W1,6s	: crystal changer error timer (1.6 seconds)

The Spectrometer Control 1 PCB contains a matrix of jumpers which enable the appropriate attenuator resistors to be matched to the selected crystals in any position of the crystal changer.

Place the bridges on the jumper pins as appropriate [see Fig. 8.1.8].

2. The voltage applied to the collimator drive mechanism valves Y8 and Y9 must be 24 V+/– V. The ripple voltage on this supply must be less than or equal to 100 mV.

5.31. SPECTROMETER CONTROL 2 [Fig. 4.7.2]

The following jumpers must be closed:

W2	: address selection
W8	: address selection
W12	: address selection
W13	: sample turret error timer (128 s)

All other jumpers are open.

5.32. SPECTROMETER CONTROL 3 [Fig. 4.8.2]

1. Jumpers

The following jumpers must be closed:

W1	: status IOBU0+ (not used in PW 1400/00)
W3	: status IOBU1+ (not used in PW 1400/00)
W5	: status IOBU2+ (not used in PW 1400/00)
W7	: status IOBU3+ (not used in PW 1400/00)
W9	: status IOBU4+ (not used in PW 1400/00)
W11	: status IOBU5+ (not used in PW 1400/00)
W12	: status IOBU7+ (not used in PW 1400/00)
W13	: status IOBU6+ (not used in PW 1400/00)
W17	: module address selection
W24	: module address selection
W27	: status IOBU1+
W29	: status IOBU2+
W31	: status IOBU3+

All other jumpers are open.

2. Display brightness

The display is built up in two parts, the segments a to g being stored in one ROM and the segments h to r in another. In order to obtain consistent overall display brightness, the segment current supplied by each of the drivers served by the ROMs can be separately adjusted.

WARNING

The circuit on which measurements must be made is at a potential of 180 V. Switch off the spectrometer before connecting probes.

Connect the two "Y" inputs of a double beam oscilloscope, one to each end of resistor R27 [B/24].

Switch on the spectrometer, set a channel (e.g. SCH CU), and set the test character "a-g" (hexadecimal code /23) into the display; the display must contain no other character (for this procedure see Chapter 7.1.2). Adjust the potentiometer R61 [A/16] until the voltage dropped over the resister R27 [B/24] is 2.14 volts.

Set the test character "h-r" (hexadecimal code /26) into the display and adjust the potentiometer R62 [D/16] until the voltage over resistor R27 [B/24] is again 2.14 volts.

5.33. WINDOW CONTROL [Fig. 4.4.6.3]

1. Reference voltage

The reference voltage, measured at pin 6 on IC D1, must be 4 V+/–0.04 V. If necessary adjust this voltage with the potentiometer R1 [D/10].

2. Lower level adjustments

With the lower level set at 00 (use command LWL0), the voltage on pin C22 of connector X3 [G/25] must be 0 V+/–2 mV. If necessary, adjust this voltage with R20 [H/20].

3. Upper level adjustment

With the window and upper level set to 00 (use command TSTCW04100) the voltage on pin 6 of IC D9 [F/22] and on pin C18 of connector X3 [F/25] must both be 0 V+/–2 mV. If necessary, adjust these voltages with R36 [F/22] and R41 [F/23] respectively.

4. Lower level and window settings

The lower level and window settings can be checked by comparing the values shown in the displays with the voltages given in the following table. The lower level voltage can be measured on pin C22 of connector X3 [G/25]. The upper level must be calculated from the display (i.e. upper level = lower level + window); the upper level voltage can be measured on pin C18 of connector X3.

Lower level	Upper level	Lower level voltages +/–0.4 % Upper level voltages +/–0.5 %
01	01	0.02 V +/–2 mV
12	12	0.24 V +/–2 mV
24	24	0.48 V +/–2 mV
48	48	0.96 V +/–2 mV
80	80	1.6 V +/–2 mV
99	99	1.98 V +/– 2 mV

5. Relationship between upper and lower levels

With the lower level set at 90 (command LWL 90) and the upper level set at 90 (UPL 90), the voltage between pins C18 and C22 may not exceed 2 mV. If necessary, correct the voltage difference with R33 [F/22]. Set the lower and upper levels at 20 and check that the difference does not exceed 2 mV. The width of the steps in the lower level voltage must be:
Units of lower level – 20 mV +/–0.4 %
Tens of lower level –200 mV +/–0.4 %

5.34. RATEMETER [Fig. 4.4.4.4]

1. Meter adjustment – mechanical

If necessary adjust the meter on the front panel of the spectrometer so that when no voltage is applied it registers zero.

2. Meter adjustment – electrical

The electrical zero for the meter can be adjusted with the potentiometer R17 [B/20].

3. Ratemeter high frequency adjustment

Using the frequency standard, apply a train of positive pulses to pin 16 on connector X4. The pulses must have an amplitude of 5 V, a width of 1 microsecond, and a frequency of 1 kHz.

Set the time constant (on the right-hand side panel of the spectrometer) to 0.1 s.

Set the ratemeter range to 10^3 (command RMS1E3).

The ratemeter should now indicate 100+/–2 microamperes. If necessary, change the value of resistors R7 [B/16] to achieve this.

4. Recorder scale adjustment

a. The chart recorder should now register full scale deflection, 100 mV. If necessary adjust this with potentiometer R84 on the counter timer display pcb [J/28].

5. Ratemeter low frequency adjustment

With the frequency standard still connected, set the frequency to exactly 100 Hz, and set the time constant control for the ratemeter to 1 or 2 seconds.

Select a ratemeter range of 10^2 (command RMS1E2). The ratemeter should register 100+/–2 microamperes. If necessary change the value of capacitance by adding a capacitor in parallel with C3 [A/19]. The value of this capacitor is 20 pF per scale division or 100 pF per microampere.

6. Autoranging adjustment

The switching points for autoranging should be approximately 101 microamps and 9 microamps. If necessary, adjust this with resistor R22 in parallel with R21 [E/3].

The system may not go into oscillation with a time constant of 10 seconds, after the range has been changed once automatically.

5.35. STEPPING MOTOR CONTROL [Fig. 4.5.4.1 and Fig. 4.5.5.1]

The slew speed of the stepping motor can be checked if necessary by closing the uppermost jumper on the stepping motor control pcb and measuring the time taken for the motor to traverse a given distance. The speed attained with the slew fast command (SLF) should be 15^{o} two theta/minute.

The speed can be checked by writing the following program into the RAM:

```
TSTW4700 3E 0C 32 68 C0 3E 09 32 75 C0 3E 01 32 68 C0 3E B0 32 70 C0
3A 70 C0 E6 80 CA 44 47 3E 02 32 68 C0 C9   RETURN

TSTW4730 3E 0C 32 68 C0 3E 08 32 75 C0 3E 01 32 68 C0 3E B0 32 70 C0
3A 70 C0 E6 80 CA 44 47 3E 02 32 68 C0 C9   RETURN
```

The test is performed as follows:

1. PTS 0
2. SLF 10 (the stepping motor runs to 10 degrees)
3. TSTE4700 (the stepping motor runs to 90 degrees; the time required is displayed on the PW 1400/00 front panel
4. TSTE4730 (the stepping motor runs to 80 degrees; the time required is displayed on the PW 1400/00 front panel.

5.36. COUNTER TIMER

The accuracy of the timer can be checked as follows:

1. Set amplifier/analyser 2 front panel switch to TEST (i.e. 10 kHz input)
2. Assemble the following job:
   AJB x
   PTS 0.1
   SCT
   PTS 1
   SCT
   PTS 10
   SCT
   EJB
3. RCJ4 (recycle job 4 times)
4. SJB x (start job)

The contents of the counter must be 10^4 x the preset time +0/−10 counts.

5.37. DEADTIME CORRECTION (see also Chapter 4.4.3.6 and Fig. 4.4.3.2)

The effect of the deadtime correction circuit can be measured as follows:

1. Assemble a copper channel if one does not already exist.

2. Set the following parameters:

SCH CU	(set copper channel)
KVM 30 10	(30 kV 10 mA)
SMP 1	(copper sample in position 1)
MSK 2	(24 mm mask)

   The intensity should now be about 50×10^3cps.
   Start a measurement of 800 s (PTS800 SCT). The resulting total counts are "I_1".
   Select filter in (FLT Y) and start a measurement of 800 s (SCT). The result is "I_2".

3. Set the following parameters:
   COL C (coarse collimator)
   MSK 2 (24 mm mask)
   KVM 30 30 (30 kV 30 mA)
   FLT N (no filter)

   Start a measurement of 60 s (PTS 60 SCT). The resulting total counts is "I_3".

   Select filter in (FLT Y) and start a measurement of 60 s. The resulting total counts is "I_4".

   Calculate: $\frac{I_1}{I_2} = A$ and $\frac{I_3}{I_4} = B$

   The deadtime loss is: $\frac{A - B}{A} \cdot 100\ \%$

   This loss must be less than 1 %.

5.38. CHANNEL NOISE LEVEL

The channel noise level can be determined as follows:

Select the following parameters:

GENERATOR	(in standby) (i.e. generator on but no kV or mA)
DET F	(Flow detector, HV normal 1680 +/–80 V)
ORD 1	(First order)
XTL 6	(Crystal attenuator set for TLAP)
SLF 90	(Goniometer set to 90°)
LWL 15	(Lower level set to 15 %)
UPL 0	(Upper level set to infinity)
PTS 10	(Preset time set to 10 s)
SCT	(Start counter/timer)

With this measurement the mean countrate may not be more than 5 counts/second.

5.39. PULSE SHIFT CORRECTION (see also 4.4.3.4 and Fig. 4.4.3.2)

The pulse shift correction may be checked as follows:

1. Assemble a copper channel if one does not already exist.

2. Select the following parameters:
   SCH CU (Set copper channel)
   KVM 30 10 (30 kV 10 mA)
   MSK 2 (24 mm mask)

3. With the oscilloscope measure the signal on measuring point 4 on amplifier/analyser 2 (flow detector signal). This must be 1 V +/–10 %.

4. Rotate the attenuator switch from "1" to the position between "1" and "2", and one second later, rotate it from this position to "2". The amplitude of the signal must not change.

5. Rotate the switch slowly back to "1". The amplitude of the signal must not change.

6. Increase the intensity from about 5.10^4 cps to about 5.10^5 cps by increasing the X-ray tube power (to about 40 kV, 60 mA).
   The amplitude of the signal must not change.

5.40. ORDER SELECTION

The attenuation required for order selection can be checked as follows:

1. Assemble a copper channel if one does not already exist.

2. Set the following parameters:
   SCH CU (Copper channel)
   SMP 1 (Copper sample)
   KVM 30 10 (30 kV, 10 mA)
   MASK2 (24 mm mask)
   The intensity should now be about 5.10^4 cps.

3. With an oscilloscope, check the signal on measuring point 4 on amplifier/analyser 2 pcb. This should be about 1 V.

4. Select ORD 2 (second order) and depress the pushbutton CALIBRATE. The signal displayed on the oscilloscope must now be reduced by half. The maximum permitted deviation from this value is 5 %.

5.41. ATTENUATOR LINEARITY

The linearity of the attenuator circuit can be checked as follows:

1. Assemble aluminium and cadmium channels if these do not already exist.

2. Set the following parameters:
   VACUUM
   SCH AL (Aluminium channel)
   KVM 30 10 (30 kV, 10 mA)
   SMP 2 (Aluminium sample)
   MSK 1 (No mask)
   COL F (Fine collimator)
   The intensity should now be about $2.5.10^4$ cps.

3. Set the chart recorder speed to 40 mm/min.

4. Draw the pulse height distribution curve with a 2 % window by selecting the following parameters:
   PHD
   WINDOW : 5 = 2
   TIME : 1 = 0

5. Repeat the pulse height distribution with the CALIBRATE pushbutton depressed. The difference is mean pulse height between the two curves must not be more than 5 %.

6. Set the following parameters:
   SCH CD (Cadmium channel)
   SMP 4 (Cadmium sample)
   KVM 0 0 (Generator manual setting)

7. Adjust the kV and mA to achieve an intensity of 2.10^4 cps.

8. Set the chart recorder speed to 40 mm/min.

9. Draw the pulse height distribution curve with the CALIBRATE pushbutton depressed:
   PHD
   WINDOW : 5 : = 2
   TIME : 1 : = 0
   The difference between this mean pulse height and the mean pulse height obtained at step 4 must not be more than 5 %.

5.42. RADIATION SAFETY

The radiation leakage from the spectrometer at a distance of 5 cm from any point on the external surface, when measured with a radiation monitor type PW 4544/07 or PW 4517/00 having a probe with a 1 cm^2 window, must not exceed 0.5 mR/hr.

The maximum permitted limits vary from one country to another. The limit given here is the specification limit for the PW 1400/00 and must not be considered to be the accepted limit for any particular country.

The following notes give some indication of how the radiation level should be measured:

1. Move the probe slowly over the whole surface area – do not forget that the window in the probe has a area of only 1 cm^2 and that this is only a small hole in the end of a relatively large probe.
   Remember also that the monitor has a fairly long reaction time, so that it is essential to move the probe slowly.

5.43. SAMPLE LOADER PW 1500/00/05/06

The sample loader PW 1500 exists in the following three versions:

/00 Universal 50/60 Hz version (discontinued – replaced by /05 and /06 versions)
/05 50 Hz version
/06 60 Hz version

The sample loader consists of a platform on which a 6-position sample tray can be fitted. A mechanism in the centre of the platform drives the tray, one position at a time, from left to right across the platform. A second mechanism drives a loading arm which moves to pick up a sample (in a sample holder) from the tray and place it in the spectrometer loading opening – after the sample has been measured, the loading arm removes the sample from the spectrometer and replaces it in the original position in the tray.
The tray is then advanced one position to the right, the next sample is loaded, and so on. The sample loader is also provided with a matrix of infrared emitters and receivers which acts as a reader for punch cards carrying program and tray number information; these cards are inserted in the sample trays as appropriate. The sample loader is also provided with several devices for detecting the position of sample holders and trays on the platform.

The sample loader may also be fitted with one of two options:

PW 1505/00 Reference tray option.

This option permits one tray of six reference samples to be held in the sample loader for use when necessary.

PW 1506/00 12-position option.

This option permits a second tray of samples to be placed on the sample loader while the samples in the previously placed tray are being measured. This allows the sample loader to be used on a continuous basis.

The sample loader is designed to operate on a 220 V, 50 or 60 Hz supply obtained from the spectrometer. If either the PW 1505/00 or the PW 1506/00 options is fitted, a supply of compressed air is required. This supply is also obtained from the spectrometer.

The platform is mounted on a frame which is mounted on castors, enabling the whole sample loader to be easily moved in front of the spectrometer, to which it is bolted during use.

Mounted on the frame are printed circuit boards containing all the necessary interface and drive electronics and power supplies.

The sample loader is provided with covers and shielding matching those of the spectrometer.

5.43.1. Grab arm mechanism (Fig. 8.5.6)

5.43.1.1. Introduction

The grab arm mechanism consists basically of a vertical shaft to which the grab arm is attached. The shaft [20] can be raised vertically by a cam [18], which is driven by a motor [M5]; the vertical movement of the grab arm is thus determined by the size of the cam. The height of the grab arm with respect to the rest of the mechanism can be adjusted by means of the set-screw [40].

The mechanism can also be rotated through a predetermined angle by means of a disc [68] and an eccentrically-mounted coupling shaft [46-53] which is driven by a motor [M4]. The length of the coupling shaft, and hence the angle through which the grab arm can be made to swing, can be adjusted when the screw [86] is loosened.

5.43.1.2. Demounting

(a) Disconnect the electrical supplies.

(b) Loosen the screw [19] in the circular mounting block [37] and demount the grab arm.

(c) Remove the screws [Fig. 3.21.3 (a) – 2] which fasten the grab arm mechanism to the adjustment bracket.

(d) Remove the three screws which fasten the grab arm mechanism to the sample loader/changer platform; two of these screws also pass through the fixing bracket [82].

(e) The complete grab arm mechanism can now be demounted.

5.43.1.3. Disassembly

The disassembly procedure can be deduced from Fig. 8.5.6. During disassembly, the following points are important:

(a) Note carefully the position and orientation of the slotted belville washers [15].

(b) Note carefully the order of assembly of the screws, washers, and spacers [46-49 and 70] used to fix the ends of the coupling shaft.

(c) Note carefully the position and orientation of the microswitches.

(d) If any of the bearings are not to be replaced, put them in polythene bags or otherwise ensure that they are kept clean.

5.43.1.4. Nonroutine maintenance

5.43.1.4.1. Cleaning

All the components can be cleaned with petroleum ether or alcohol (ethanol) except for the bearings. Clean the bearings with a clean lint-free cloth.

5.43.1.4.2. Lubrication

Lubricate the sleeve bearings and the vertical guides [34] with Molykote BR2.

5.43.1.4.3. Reassembly

Reassemble the components in the reverse order to that used for disassembly. Take particular care to reassemble the microswitches, belville washers, etc., in the correct order as noted in 5.43.1.3.

5.43.1.5. Remounting

Remount the assembly using the reverse procedure to that used for demounting.

5.43.1.6. Alignment and adjustment

5.43.1.6.1. Vertical movement

Two adjustments affect the vertical movement – the positioning of the guide strips [34] and the set-screws [B].

(a) Place a precision set-square on the platform of the sample loader/changer so that it just touches the end of the grab arm.

(b) Raise and lower the grab arm carefully by turning the cam [18] slowly by hand. The distance between the grab arm and the set-square may not exceed 0,5 mm. If this distance is exceeded, loosen the screws [A] which fasten the mechanism to the platform and adjust the set-screws [B]. Retighten the screws [A] and check the vertical movement again.

(c) If necessary, adjust the position of the guide strips [34] to ensure that the vertical movement takes place without any noticeable sideways movement and without any stiffness.

(d) Press lightly with the hand on the end of the grab arm — the movement, checked with a set-square, may not exceed 0,2 mm.
Movement in excess of this suggests worn bearings.

5.43.1.6.2. Grab mechanism

The grab mechanism consists of two spring-loaded plastic grab hooks [56]; the distance between these can be adjusted with the set-screws [60]. The grab mechanism must be able to pick up a sample holder without difficulty and without jamming. During movement of the grab arm, the grab mechanism must hold the sample holder firmly and must not let it fall.

Adjust the grab hooks with the set-screws [60] so that the distance between them is 57 +0, 5/—0 mm.

The spring pressure exerted by the grab hooks should be 60 + 10/—0 g.

5.43.1.7. Operational check

Check the correct operation of the mechanism using test commands as detailed in chapter 7.

The movement of the grab arm should stop correctly in all of the following conditions:

(a) Grab arm low and in sample changer pick up position

(b) Grab arm high and in spectrometer loading position

(c) Grab arm low and in the rest position

In addition, the horizontal unload movement should stop correctly in all of the following conditions:

(d) Grab arm low and in spectrometer loading position

(e) Grab arm high and in sample changer pick up position

(f) Grab arm low and in the rest position

5.43.2. Tray transport mechanism

5.43.2.1. Introduction

The sample transport mechanism consists of a horizontal motor-driven disc which has two pins in its upper surface. As the disc rotates, the pins engage in slots in the underside of the sample tray, causing the tray to be shifted from left to right. The rest positions of the transport disc are determined by microswitches.

5.43.2.2. Demounting [Fig. 8.5.7. (b)]

(a) Loosen the three screws [6] and demount the transport disc [48]. Note carefully the order of assembly of the serrated washers [53]. The motor M1 [4] can now be demounted after the four screws [43] have been removed.

5.43.2.3. Nonroutine maintenance

5.43.2.3.1. Cleaning

The components of the assembly may be cleaned with petroleum ether or alcohol (ethanol).

5.43.2.3.2. Lubrication

None of the components of this assembly should be lubricated.

5.43.2.4. Remounting

Remount the components in the reverse order to that used for demounting. Ensure that the serrated washers [53] are reassembled in the correct manner. Set the disc [48] on the motor shaft so that the upper surface of the disc is flush with the surface of the platform and the drive pins are oriented so that a sample tray can slide across the platform without touching the pins.

5.43.2.5. Alignment, adjustment, and electrical checks

5.43.2.5.1. Microswitches

The microswitches should be adjusted and their operation checked with the aid of a sample tray placed in the appropriate position on the platform.

The two hexadecimal characters which are displayed/printed continuously when each of the following test commands is given, must be interpretted as shown in chapter 7.1.13.

(a) Tray position
Type the command: TSTCRC08F cr

The two hexadecimal characters which are displayed/printed must be interpretted as shown in chapter 7.1.13.

(b) Grab arm
Type the command: TSTCRC087 cr

5.43.2.5.2. Sample detector and optical reader

(a) Sample detector
Type the command: TSTCRC087 cr

The voltage measured over R21 on the microswitch buffer pcb must be as follows:

Lamp/LED off or light receiver covered: 1.5 V

Lamp/LED on and light falling on light receiver: 11 V

(b) Optical reader
Type the commands: TSTCRC083 cr and TSTCRC08B

The voltage measured between the connector points 1, 2, 4 to 15, 17, and 18 on the microswitch buffer pcb should be as follows:

For a LED opposite a program card position with no perforation: $\leqslant$3 V

For a LED opposite a perforated program card position: $\geqslant$10 V

5.43.2.5.3. Grab arm

The adjustment procedure for the grab arm is given in chapter 3.21.4.1.

5.43.2.5.4. Busy signals

When one of the motors of the sample loader is running, the busy LED on the PW 1400/00 must be lit. The busy signals can be individually checked by giving the command TSTRC08D. The meaning of the resulting hexadecimal output can be found in chapter 7.1.13.

5.43.2.5.5. Protective timers

The motors of the sample loader are protected by timers on the sample changer control pcb [see also fig. 4.11.3.1.]. The operation of these timers can be checked as follows:

Remove the plug from the motor drive pcb and the compressed air connection from the PW 1505/00 or PW 1506/00, if fitted. Set the monitor tray in the middle position, if necessary. When a start command is given for one of the motors, the related busy signal and the SCC busy signal should be true; after a time determined by the appropriate timer, the SCC busy signal will become not true. The timing for the busy signals is:

PW 1505/00 and PW 1506/00	:	6	seconds
Grab arm, vertical and horizontal	:	12,8	seconds
Tray transport	:	6	seconds

The busy signals can be reset by giving the command TSTWC08780.
This will also cause the sample loader to be switched off; it can be switched on again by giving the command TSTWC08701.

5.43.2.6. Operational check

Check the operation of the sample loader using a tray with samples and the tests given in chapter 7.6.

5.44. REFERENCE TRAY OPTION PW 1505/00

5.44.1. Introduction

The reference tray option is a device which can be fitted to the sample loader PW 1500/00/05/06 to enable a tray of reference samples to be held ready for use on the loader. On command the reference tray can be brought to the loading position and after use, returned to the rest position. The reference tray option does not interfere with the normal operation of the sample loader.

The reference tray option requires a compressed air connection – this is obtained from the PW 1400/00 (see chapter 3.21.3.).

5.44.2. Demounting

(a) Remove the front cover from the sample loader.

(b) Disconnect the compressed air supply at the quick release connector on the reference tray option.

(c) Disconnect the electrical supply.

(d) The reference tray option is attached to the frame of the sample loader by four screws – these can be reached via holes in the platform of the sample loader. When these screws have been removed, the reference tray option can be slid out from the front of the loader.

5.44.3. Disassembly

The procedure for disassembly can be deduced from fig. 8.5.8.
Ensure that the compressed-air actuator and the valves are kept clean and free from dust or damp; this can best be done by sealing the pipe connections with plastic covers or by enclosing the actuator and valves in plastic bags.

5.44.4. Nonroutine maintenance

5.44.4.1. Cleaning

All the components can be cleaned with petroleum ether or alcohol (ethanol).

The compressed-air actuator is lubricated for life; it's internal surfaces should therefore not be cleaned.

The central stems of the valves can be unscrewed for cleaning and renewal of the O-rings.

5.44.4.2. Lubrication

The reference tray option requires no lubrication. If the lubrication of the actuator has failed, it will be necessary to renew the whole component.

5.44.4.3. Reassembly

Reassemble the components in the reverse order to that used for disassembly.

5.44.5. Remounting

Remount the reference tray option by inserting it in the sample loader and fixing it in position with the four screws removed during demounting. Ensure that the movable guide strips on the reference tray option are free to move before the fixing screws are finally tightened.

Reconnect the electrical connectors and the compressed-air.

5.44.6. Alignment, adjustment, and electrical checks

5.44.6.1. Mechanism movement

(a) Check, using test commands, that the unit operates correctly.

(b) Place a sample tray with six samples in sample holders in the reference tray option. Check that with an air pressure of 4 atmospheres the movement of the tray completed in between 1 and 2 seconds.

(c) With the sample tray still in position, check that with an air pressure of 2,5 atmospheres the movement of the tray does not take more than 2,5 seconds.

(d) If either of the movements specified in (b) or (c) is not completed in time, adjust the restriction [fig 8.5.8. item 44].

5.44.6.3. Microswitches

Check the operation of the microswitches by typing the command TSTCRC08F and comparing the resulting hexadecimal printout with the information given in chapter 7.1.13. If necessary, adjust the microswitches to obtain the correct results. This check must be made with the tray in all the possible positions.

5.44.6.4. Electrical recognition signals

Check that the presence of the reference tray option is correctly signalled by typing the test command TSTRC087 and comparing the resulting hexadecimal printout with the information given in chapter 7.1.13.

5.44.6.5. Busy signals

Check that the setting LED on the spectrometer lights during the movement of the actuator.

The busy signals can be checked by typing the test command TSTRC08D and comparing the resulting print-out with the information given in chapter 7.1.13.

5.44.6.6. Safety timers

Disconnect the plug from the motor drive pcb and set the reference tray mechanism in the middle position and disconnect the compressed air. If the unit is now activated, the relevant busy signal and the SCC busy signal will be true. Check that after 25,6 seconds the SCC busy signal becomes not true.

Reset the busy signals by typing TSTWC08780.

Reconnect the plug and the compressed air.

5.44.6.7. PCB voltages

Using an oscilloscope, measure the following voltages:

The voltage over C1 must be 33,6 ± 0,2 V peak-to-peak with a ripple of ⩽2,5 V.

The voltage between the negative end of C1 and the cathode of either V2 or V3 must be 24 V ± 10% and the ripple and/or oscillation may not exceed 100 mV with the circuit under load; the circuit can be loaded by giving the test command TSTWC08701 or TSTWC08740 or the commands SRT or FRT.

5.44.7. Operational check

Check the operation of the reference tray option using the test commands given in chapter 7.6.

5.45. 12-POSITION OPTION PW 1506/00

The 12-position option is basically similar to the reference tray option except that the slide mechanism for moving the tray is different [see fig. 8.5.8.]. The option permits a second tray of samples to be placed in position on the sample loader while the first is still being measured, thus permitting continuous working.

All the information given in chapter 5.44 concerning the reference tray option PW 1505/00 applies equally to the 12-position option.

5.46. SAMPLE CHANGER PW 1500/10/15/16

5.46.1. Introduction

The sample changer exists in the following three versions:

/00 Universal 50/60 Hz version (discontinued — replaced by /15 and /16 versions)
/15 50 Hz version
/16 60 Hz version

The sample changer consists of a platform on which up to 12 sample trays can be placed, thus permitting up to 72 samples to be loaded sequentially into the spectrometer and measured according to a variety of measuring programs.

The sample changer is provided with three mechnisms to enable the sample trays to be positioned on the platform and one to enable sample holders to be loaded into the spectrometer as follows:

(a) A mechanism in the centre of the platform at the spectrometer side which drives the tray, one position at a time, from left to right and from right to left across the platform.

(b) A mechanism which drives two pairs of belts — these carry the sample trays clockwise round the platform.

(c) A mechanism in the centre or the platform at the front which drives the tray, one position at a time, from right to left across the platform.

(d) A mechanism to drive the loading arm which moves to pick up a sample holder from the tray in the centre of the platform at the spectrometer side and place it in the spectrometer loading opening — after the sample has been measured, the loading arm removes the sample holder from the spectrometer and replaces it in the original position in the tray. The tray is then advanced one position to the right, the next sample is loaded, and so on. The sample changer is also provided with a matrix of infrared emitters and receivers which acts as a reader for punch cards carrying program and tray number information; these cards are inserted in the sample trays as appropriate.
The sample changer is also provided with several devices for detecting the position of sample holders and trays.

The sample changer is designed to operate on a 220 V, 50 or 60 Hz supply obtained from the spectrometer.

The platform is mounted on a frame which is mounted on castors, enabling the whole sample changer to be easily moved in front of the spectrometer, to which it is bolted during use.

Mounted on the frame are printed circuit boards containing all the necessary interface and drive electronics and power supplies.

The sample changer is provided with covers and shielding matching those of the spectrometer.

5.46.2. Removal of the covers

The covers at both the front and the rear of the sample changer are secured with screws which must be removed before the covers can be removed. In addition, (starting with serial number DY701) both these covers are prevented from interfering with the smooth movement of the sample trays at the front and back of the platform by screws which press the covers towards the outside of the sample changer. For the front cover, access to these screws is gained via holes in the vertical strip on the top of the platform [fig. 8.5.9 item 91]. For the rear cover, access is gained via holes in the rear cover itself.

Sample changers with serial numbers up to and including DY700 should have been modified by the addition of two brass guide blocks which have the same function as the screws previously mentioned.

CAUTION

Ensure that the above mentioned screws are loosened before attempting to remove the covers — failure to do this can result in the covers being damaged.

5.46.3. Grab arm mechanism

The grab arm mechanism is identical to that fitted to the sample loader PW 1500/00/05/06. See chapter 5.43.1.

5.46.4. Tray transport mechanism — spectrometer side [fig. 8.5.9]

The tray transport mechanism on the spectrometer side is identical to that fitted to the sample loader PW 1500/00/05/06. See chapter 5.43.2.

5.46.4. Tray transport mechanism — front side

The tray transport mechanism at the front of the sample changer is similar to that at the spectrometer side. See chapter 5.43.2.

5.46.5. Transport belt mechanism

5.46.5.1. Introduction

Two pairs of transport belts are fitted to the sample changer – these serve to transport the sample trays across the platform. The belts on the right-hand side transport the trays from the spectrometer side to the front side and those on the left-hand side transport the trays in the reverse direction, [see fig. 8.5.9]. The belts are driven by a motor, M3, via a secondary belt [37], a lay shaft [38], and a set of bevel gears [9].

5.46.5.2. Disassembly

The outer belts are easily removed by slipping them off their respective pulleys. The inner belts can only be removed after the drive shafts [6] have been disassembled. The drive shafts are retained in the ball bearings [5] by the circlips [4], and the bearings are in turn retained, in brackets welded to the underside of the platform, by screws [44]. When these screws are removed the drive shafts can be withdrawn and the belts slipped off their pulleys. If necessary, the tension on the belts can first be released by loosening the nuts [58], thus allowing the pulleys [118] to move towards the centre of the platform.

The disassembly of the other components can be inferred by reference to fig. 8.5.9.

5.46.5.3. Belt tension

The tension of the transport belts can be adjusted after the nuts [58] retaining the pulleys [118] at the spectrometer side of the platform have been slightly loosened.

5.46.5.4. Alignment, adjustment, and electrical checks

The microswitches and the proggram card reader must always be adjusted with the aid of a sample tray, which should be placed so as to actuate the microswitch. This ensures tha the microswitch will be operated correctly when the sample changer is in normal use.

The alignments, adjustments, and electrical checks given in chapter 5.43.2.5. for the sample loader apply equally to the sample changer.

The operation of the belt limit timer [fig. 4.11.3.2. H/6] can be checked by typing the test command TSTWC08F80 – with no sample tray on the platform, the transport belts should start and should stop automatically after 25,6 seconds.

Start the transport belts by typing the test command TSTWC08F80 and check that they are stopped when either of the following combinations of microswitches is actuated:

S14 and S16 or S11 and S15

5.47. SAMPLE CHANGER CONTROL PCB

The sample changer control pcb provides the necessary control and interface functions to enable the sample loader PW 1500/00/05/06, the sample changer PW 1500/10/15/16, the reference tray option PW 1505/00, the 12-position option PW 1506/00, and the Herzog sample changers to be connected to the spectrometer PW 1400/00. The operation of the total system remains under the control of the CPU, while the firmware for the sample loader/changer and the options is provided by a separate pcb PW 1502/00. When a Herzog sample changer is fitted, the firmware is provided by a pcb PW 1502/40. All of these pcbs are mounted in the upper electronics rack in the spectrometer [see fig. 3.21.2.3.].

The sample changer control pcb is provided with jumpers for various address and control functions.

The following jumpers must be closed on pcbs used in conjunction with all types of sample loaders/changers:

W5	Module address
W9	Module address
T1-11	Belt limit timer
T2-6	Belt limit timer
TIME1 +	Motor error timer
TIME2 +	Motor error timer
A	Motor busy

The following jumpers must be closed on pcbs used in conjunction with the sample loader PW 1500/00/05/06:

B1–B2
C1–C2
C1–C4
D1–D2
E1–E2
F1–F6
F2–F3

All other jumpers must remain open.

The following jumpers must be closed on pcbs used in conjunction with the sample changer PW 1500/10/15/16:

A–P
C2–C3
C4–C5
D2–D3
E2–E3
F1–F6
F2–F3
F3–F5
F4–F6

All other jumpers must remain open.

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6. PREVENTIVE MAINTENANCE

6.1. INTRODUCTION

Regular preventive maintenance increases the life of a spectrometer and helps to keep the accuracy and reproducibility of the equipment at an optimum level. It also helps to ensure that the minimum amount of time will be lost because of breakdowns, and that the number of service visits will be kept to a minimum.

The preventive maintenance schedule given in this chapter is the minimum necessary to ensure reliability. It is based on two maintenance visits per year at approximately six-monthly intervals, alternate visits requiring an extended schedule.

6.2. EVERY 6 MONTHS

a. Check all the following filters and clean or renew them as necessary:

- Water system
- Detector gas system
- Air inlet
- Vacuum system
- Compressed air system.

b. Goniometer

- Check the oil level in the goniometer wormhouse, and top up if necessary with Shell Tellus 33.

c. Vacuum pump

- Check the oil level and top up if necessary with Edwards Speedivac No. 16 or No. 15 oil, as appropriate
- Check the condition and tension of the driving belts, and renew if necessary.
- Check the condition of the alumina filling in the foreline trap. If it contains water, dry it by baking in an oven. If it contains oil, renew it.

d. Spinner drive mechanism

- Renew the quadring.
- Examine the vacuum sealing surface on the shaft. If it is scratched or worn, renew the shaft.
- Grease the shaft and quadring with Molykote 44 medium grease.

e. Detector arm

- Remove the screw from the grease point. Lubricate the detector arm with three drops of Shell Tellus 27.

f. Collimator drive mechanism hydraulic shock absorber.

- Check the shaft seals for leakage. The shaft may have a film of oil but there must be no drops of oil present.
- Examine the oil passing through the transparent tube during operation of the collimator mechanism. During the whole movement of the shaft there must not be more than two air bubbles between 2 and 5 mm diameter and not more than five air bubbles of 1 mm diameter apparent.
  If more bubbles than this are present, renew the shock absorber.

g. Gearwheels

- Lightly grease the gearwheels on the collimator drive mechanism and the crystal chamber cover with Shell Macoma 69.

h. Gas flow detector

- Check the resolution. If this is poor or unacceptable, clean the flow detector and renew the detector wire and windows.

CAUTION

Do not use grease on the O-rings in the gas flow detector.

j. Safety circuits

- Check the operation of both safety circuits.

k. Temperature stabilization system

- Check the function of the heater and both coolers. Check also that the system is adjusted to produce a correctly balanced heating/cooling cycle.

6.3. EVERY 12 MONTHS

a. Carry out the 6-monthly maintenance schedule given in 6.2. In addition, carry out the following schedule:

b. Vacuum seals

- Renew the following dynamic vacuum seals:
  - Sample turret shaft seal.
  - Plunger seals.
  - Filter seal.
  - Collimator seal.
  - 1 θ and 2 θ shaft seals.
  - Crystal changer mechanism shaft seal.
  - Mask shaft seal.

  Examine the sealing surfaces on the shafts. If there is any sign of scratching or wear, renew the shaft concerned.
  Grease all the dynamic seals and shafts with Molykote 44 medium grease.
- Renew the following static vacuum seals:
  - X-ray tube entry seal.
  - Cap unit seal.
  - Plunger head seal.
  - Airlock seal on underside of sample chamber cover.

  Lightly grease all the static seals with Apiezon L or M

c. Crystal chamber

- Renew the crystal chamber window and the O-ring.

d. Oil

- Drain the oil from the vacuum pump and fill with fresh oil. Run the vacuum pump for 12 hours on "gas ballast".
- Drain the oil from the goniometer wormhouse and fill with fresh oil.
- If an oil mister is used with the compressed air system, drain and fill with fresh oil.

e. Compressed air system

- Clean all restrictions.
- Examine all actuators (cylinders) to ensure that they are free running. Renew any worn or stiff actuators.

f. Sample turret

- Clean the turret.
- Examine all bearings to ensure that they run freely. Renew any worn or stiff bearings.

g. Crystal changer

- Clean the crystal changer.
- Check that the mechanism runs freely.
- Lubricate the bearings with Molykote Mikrofine Powder.
- Lightly grease the pivot points of the crystal holders with Shell Tellus 33.

h. Crystal chamber cover

- Clean the crystal chamber cover.
- Check the condition of the gearwheels and bearings. Renew any worn parts.
- Check the operation of the microswitches.

j. Collimator drive mechanism

- Check the condition of the bearings, gearwheels, and drive fork. Renew all worn parts.

k. Spinner drive mechanism

- Check that the spinner runs freely and evenly, both with and without the sample turret in position.
- Check the condition of the gearwheel and the bearings. Renew any worn parts.

l. Filter drive mechanism

- Examine the vacuum sealing surface on the shaft. If this is worn or scratched, renew the shaft.

m. Goniometer

- Uncouple the stepping motor and check that the goniometer turns freely and evenly by hand over the whole angular range.
- Check over the whole angular range that adequate spring tension is applied to the 1 θ and 2 θ gearwheels (i.e. no backlash must be present between the gearwheels).

n. Plunger mechanism

- Check that the plunger runs freely and evenly in the cylinder. Renew the bearings if necessary.

p. Cooling fans

- Examine all the air circulating fans. Renew any fan that is faulty or noisy.

q. Heater

- Check that the heater works correctly.

r. Water by-pass valves

- Disassemble both water by-pass valves, clean and reassemble them, and check for correct working.

s. Vacuum and helium valves

- Disassemble and clean the valves.
- Renew the O-rings.
- Reassemble the valves and check that they work correctly.

t. X-ray tube

- Clean the tube water circuit with a solution of 10 % acetic acid in water.

u. Sample Loader PW1500/00/05/06 (if fitted)

- Check that the arm mechanism moves freely in the vertical direction, and that it moves downwards under its own weight.
- Check that there is not too much play in the vertical movement of the arm mechanism. If necessary, adjust it as described in chapter 5.
- If the arm mechanism is provided with a felt oiler for the cam, saturate this with vacuum oil. Do not grease the vertical shaft.
- Check that the arm mechanism motor operates correctly.
- Check the operation and adjustment of all microswitches.
- Check the operation and adjustment of the unit under all conditions.
- Clean the whole unit as necessary. The transport plate must be free from dirt.

v. Sample Changer PW1500/10/15/16 (if fitted)

- Carry out all the actions listed under **u**. These are basically the same for both Sample Loaders and Sample Changers.
- Check the operation of the two spring-loaded pawls, (one at the centre front and one at the centre rear of the transport platform), which prevent reverse movement of the sample trays. The spring pressure exerted by these pawls must be $\approx$ 60 g.
- Check that the transport belts run smoothly, and that they are not worn.

w. Reference Tray Option PW1505/00

- Check the operation of the compressed air valves.
- Check the operation of the transport slide mechanism. Do not use grease on the shaft.
- Check the operation and adjustment of all microswitches.
- Check the operation and adjustment of the unit as a whole.

x. 12-position Option PW1506/00

- Carry out all the actions listed under **w**. These are basically the same for both Reference Tray and 12-position options.

6.4. CONSUMABLE MATERIALS

A list of consumable materials for use in preventive maintenance is given in Chapter 8.
Chapter 8 also contains the ordering codes of all the renewable parts mentioned in this chapter.

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CHAPTER 7. TESTS AND TEST METHODS

Because the PW 1400/00 is a microcomputer-based system many test procedures can be based on the use of the normal software. Thus, for example, a long term stability test can be assembled in the form of a JOB to be repeated a given number of times.
In addition to the normal user's software, the PW 1400/00 is provided with two other test facilities, in the form of an automatic start-up test which checks the operation of the microprocessor and the memory, and a series of test commands by means of which the service engineer can check each function of the spectrometer individually. Furthermore, since the system is based on a microprocessor with a accessible memory, it is possible to write programs using any or all of the available microprocessor instruction set.

This chapter includes a description of these test methods and gives some examples of programming. In addition, a series of acceptance tests is included. These tests are intended to be carried out after installation, and each time the spectrometer is serviced. They are intended to give a degree of certainty that the spectrometer is correctly aligned and in good working order.

7.1. USE OF TEST COMMANDS

For the PW 1400/00 microprocessor a series of test commands is available. These commands are constructed from the following elements:

TST — TEST command. These three characters form the first part of all test commands.

C — CONTINUOUS. A character which can be inserted optionally to cause the microprocessor to continuously repeat the required action.

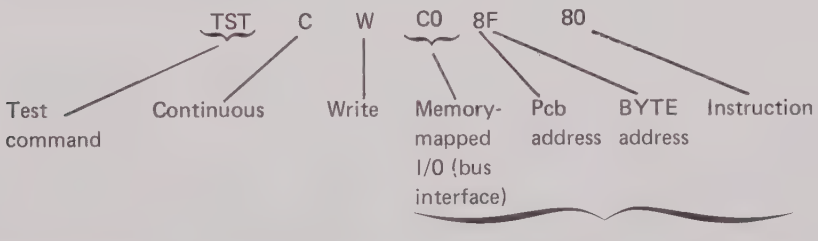
W — WRITE. Causes the required information to be written onto the data bus.

R — READ. Causes the required information to be read from the bus and displayed or printed out.

E — EXECUTE. Causes a program written into the RAM to be executed.

In addition to these elements the test command must include the pcb address (4 bits), the byte address (4 bits) and the data (instruction) to be carried out (written onto the data bus).

Construction of test command



This typical test command causes the transport belts on the sample changer to move continuously. In practice, test commands are entered without spaces, i.e. TSTCWC08F80.

Further examples

1. TST R 4000

Causes the RAM address 4000 to be interrogated once and the contents to be displayed or printed.

2. TST C R 40FF

Causes the RAM address 40FF to be interrogated continuously and the contents to be repeatedly displayed or printed.

3. TST R 4000 00FF

Causes the contents of all the RAM addresses between 4000 and 40FF (i.e. 225 addresses) to be displayed or printed.

4. TST W C0 10 08

Causes "Filter in" to be selected.

Notes:

1. In the accompanying bit pattern tables the addresses are given in hexadecimal form and the data (instructions) are given in BCD form. For use the data (8 bits) must be converted to two hexadecimal digits.
2. In the lists of test commands the commands are given in the form in which they must be used (i.e. in hexadecimal form).
3. Microprocessor programs in machine code (hexadecimal) can be written into the RAM and executed using the test commands. Such programs must be based on the 8080 microprocessor instruction set.
4. All addresses can be read continuously and displayed, for example, on a VDU. This makes it possible to observe any change which takes place in the data available at that address. Thus, for example, the change in the state of a microswitch can be observed directly, making it possible to check not only the action of the microswitch itself, but the relevant wiring and connector points without making any measurements. It is thus also possible to check the status of every function without opening the spectrometer.

Addresses

CPU + PROM	00 00	–	3F FF
RAM	40 00	–	47 FF
Serial interface No. 1	90 00	–	90 03
Serial interface No. 2	A0 00	–	A0 03
Bus interface – Bus address	C0 00	–	C0 FF
Window control	C0 41	–	C0 43
Ratemeter	C0 50		
Counter-timer	C0 60	–	C0 6F
Position control	C0 70	–	C0 76
Spectrometer Control 1	C0 10	–	C0 12
Spectrometer Control 2	C0 20	–	C0 23
Spectrometer Control 3	C0 30	–	C0 34
Sample changer control	C0 83	–	C0 8F
Reset interrupts	E0 00		

7.1.4. Bus interface pcb bit patterns

READ C0A_1A_2

D7							D0
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0

Data from equipment bus

WRITE C0A_1A_2
(A_1 = card address)
(A_2 = byte address)

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0

Data to equipment bus

WRITE E000

X	X	Reset INTR5	Reset INTR4	Reset INTR3	Reset INTR2	X	X

7.1.5. Serial interfaces 1 and 2 bit patterns

	Serial I/F nr. 1	Serial I/F nr. 2	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
READ	9000	A000	Data from terminal							

			Data set ready (107)	sync. detect	framing error	overrun error	parity error	trans-mitter empty	receiver ready	trans-mitter ready
READ	9001	A001	Status from USART							

			1	1	parity check	parity check	1	0 = 7 1 = 8	1	0
READ	9002	A002	number of stop bits = 2		0 = odd 1 = even	0 = no 1 = yes	number of bits per character		baud rate factor = 16	

Data from switches for "MODE" setting

			Data car. detect 0 = ON 1 = OFF	X	X	Echo 0 = no 1 = yes	0	0	0	1
READ	9003	A003	Data carrier detected (109) + card identification							

			bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
WRITE	9000	A000	Data to terminal							

			bit S2 bit S1 no. of stop bits 0 1 = 1 bit 1 0 = 1½bit 1 1 = 2	parity check 0 = odd 1 = even	parity check 0 = no 1 = yes	bit L2 bit L1 number of bits per character 00 = 5 10 = 7 01 = 6 11 = 8	bit B2 bit B1 baud rate factor 00 = sync 10 = 16x 01 = 1x 11 = 64x
WRITE	9001	A001	"MODE" instruction				

			Enable hunt mode	Return to initiali-sation	request to send (105) 0 = OFF 1 = ON	reset error flags	0 = normal 1 = send breaks	receiver 0 = dis-able 1 = enabl	data term. rdy 0 = OFF 1 = ON	trans-mitter 0 = dis-able
WRITE	9001	A001	"COMMAND" instruction							

7.1.6. Window control pcb bit patterns

WRITE C041

bit 8	bit 4	bit 2	bit 1	bit 8	bit 4	bit 2	bit 1
Tens of window setting (in BCD)				Units of window setting (in BCD)			

WRITE C042

bit 8	bit 4	bit 2	bit 1	bit 8	bit 4	bit 2	bit 1
Tens of lower level setting (BCD)				Units of lower level setting (BCD)			

WRITE C043

pulse shift corr. 0 = ON 1 = OFF	recorder ON	infinite window	increm. lower level with recorder pulses	bit 8	bit 4	bit 2	bit 1
				Tenths of lower level setting (BCD)			

Window control test commands

Notes
1. To set lower level and window it is necessary to use continuous write commands. It is therefore possible to set only one at a time.
2. For the settings to be realistic, the sum of lower level and window must not exceed 100.
3. Results of setting the tenths of lower level are not displayed.

Window setting	TSTCWC041 pq	[p = 0-9 (tens) q = 0-9 (units)]
Lower level tens & units	TSTCWC042 xy	[x = 0-9 (tens) y = 0-9 (units)]
Lower level (tenths)	TSTCWC0430 z	[z = 0-9 (tenths)]
Pulse shift correction OFF	TSTWC0438 z	[z = tenths of lower level]
Pulse shift correction ON	TSTWC0430 z	
Recorder ON	TSTWC0434 z	
Infinite window	TSTWC0432 z	
Increment lower level with recorder pulses	TSTWC0431 z	

7.1.7. Ratemeter pcb bit patterns

WRITE C050

D7							D0
X	X	X	X	bit R3	bit R2	bit R1	bit R0

R3	R2	R1	R0	ratemeter range (counts per second)
0	0	0	0	manual selection
0	0	0	1	1.10^2
0	0	1	0	2.10^2
0	0	1	1	5.10^2
0	1	0	0	autoranging
0	1	0	1	1.10^3
0	1	1	0	2.10^3
0	1	1	1	5.10^3
1	0	0	1	1.10^4
1	0	1	0	2.10^4
1	0	1	1	5.10^4
1	1	0	1	1.10^5
1	1	1	0	2.10^5
1	1	1	1	5.10^5

Set ratemeter range test commands

Manual selection	TSTWC05000
1×10^2	TSTWC05001
2×10^2	TSTWC05002
5×10^2	TSTWC05003
Autoranging	TSTWC05004
1×10^3	TSTWC05005
2×10^3	TSTWC05006
5×10^3	TSTWC05007
1×10^4	TSTWC05009
2×10^4	TSTWC0500A
5×10^4	TSTWC0500B
1×10^5	TSTWC0500D
2×10^5	TSTWC0500E
5×10^5	TSTWC0500F

7.1.8. Counter timer bit patterns

	D7							D0
READ C060 (= decade 0) to READ C067 (= decade 7) msd	X	X	X	X	bit 8	bit 4	bit 2	bit 1
					counter decade (in BCD)			
READ C06F (= decade 0) to READ C06A (= decade 5) msd	X	X	X	X	bit 8	bit 4	bit 2	bit 1
					timer decade (in BCD)			
WRITE C064 (= decade 4) to WRITE C067 (= decade 7) msd	X	X	X	X	X	bit 4	bit 2	bit 1
					preset count decade (BCD)			
WRITE C068	X	reset preset FFs	set preset time FF	set preset count FF	reset counter	reset timer	stop counter timer	start counter timer
WRITE C06F (= decade 0) to WRITE C06A (= decade 5) msd	X	X	X	X	bit 8	bit 4	bit 2	bit 1
					preset time decade (in BCD)			

Counter timer test commands

Display counter decade	0	TSTRC060	
	1	TSTRC061	
	2	TSTRC062	
	3	TSTRC063	
	4	TSTRC064	
	5	TSTRC065	
	6	TSTRC066	
	7	TSTRC067	
Display timer decade	0	TSTRC06F	
	1	TSTRC06E	
	2	TSTRC06D	
	3	TSTRC06C	
	4	TSTRC06B	
	5	TSTRC06A	
Set preset count decade	4	TSTWC0640x	[x = 0 - 7 (*)]
	5	TSTWC0650x	
	6	TSTWC0660x	
	7	TSTWC0670x	
Set preset time decade	0	TSTWC06F0y	[y = 0 - 9]
	1	TSTWC06E0y	
	2	TSTWC06D0y	
	3	TSTWC06C0y	
	4	TSTWC06B0y	
	5	TSTWC06A0y	

Reset preset flip-flops	TSTWC06840
Set preset-time flip-flop	TSTWC06820
Set preset-count flip-flop	TSTWC06810
Reset counter	TSTWC06808
Reset timer	TSTWC06804
Stopccounter-timer	TSTWC06802
Start counter-timer	TSTWC06801

(*) It is possible, using test commands, to set these digits to all values from 0 to 7. When the software commands PCS iEj are used, these digits may only have the values 0, 1, 2 and 5.

7.1.9. Position control pcb bit patterns

	D7							D0
READ C070	ready	error	equal	X	calibrate	scanning	count up	index
READ C071 (= decade 0) to READ C076 (= decade 5) msd	X	X	X	X	bit 8	bit 4	bit 2	bit 1
					position indication decade (BCD)			
WRITE C070 "STOP"	0	X	X	X	X	X	X	X
WRITE C070 "SLEW"	1	X	0=fast 1=slow	direction 0 = up 1 = down	0	X	X	X
WRITE C070 "SCAN"	1	X	X	direction 0 = up 1 = down	1	bit S2	bit S1	bit S0
						S2 S1 SØ	speed (°2Ø/m)	
						0 0 0	32	
						0 0 1	16	
						0 1 0	8	
						0 1 1	4	
						1 0 0	2	
						1 0 1	1	
						1 1 0	1/2	
						1 1 1	1/4	
WRITE C071 (= decade 0) to WRITE C076 (= decade 5) msd	X	X	X	X	bit 8	bit 4	bit 2	bit 1
					setpoint decade (in BCD)			

Position control test commands

Display angle decade	0	TSTRC071
	1	TSTRC072
	2	TSTRC073
	3	TSTRC074
	4	TSTRC075
	5	TSTRC076
Set angle decade	0	TSTWC0710x [x = 0 - 9]
	1	TSTWC0720x
	2	TSTWC0730x
	3	TSTWC0740x
	4	TSTWC0750x
	5	TSTWC0760x
Stop		TSTWC07000
Slew fast up		TSTWC07080
Slew fast down		TSTWC07090
Slew slow up		TSTWC070A0
Slew slow down		TSTWC070B0
Scan up 32° 2θ/min		TSTWC07088
16		TSTWC07089
8		TSTWC0708A
4		TSTWC0708B
2		TSTWC0708C
1		TSTWC0708D
Scan up ½		TSTWC0708E
¼		TSTWC0708F
Scan down 32° 2θ/min		TSTWC07098
16		TSTWC07099
8		TSTWC0709A
4		TSTWC0709B
2		TSTWC0709C
1		TSTWC0709D
½		TSTWC0709E
¼		TSTWC0709F

7.1.10. Spectrometer control 1 bit patterns

	D7							D0
READ C010	mask 2	mask 1	coll F	coll C	0	X-tal bit 4	X-tal bit 2	X-tal bit 1
READ C011	0	0	0	filter out	filter in	PB 'helium' not	PB 'air' not	PB 'vac' not
READ C012	system* busy	0	0	BUSYL line	X-tal busy	coll busy	mask busy	filter busy
WRITE C010	X	X	X	select X-tal motor	select filter	select mask	select coll	1 pos./IN/ 2/F=0 UP / 1 pos./OUT/ 1/C=1 DOWN
WRITE C011	X	X	X	X	X	00=sc det. (det.2) 01=fl det. (det. 1) 10=order 11=analyse lamp		OFF/2/ not select=0 / ON/1/ select=1

* Disappearance of this bit gives interrupt 4.

Spectrometer control 1 test commands

Set mask 1	TSTWC01005
Set mask 2	TSTWC01004
Set collimator coarse	TSTWC01003
Set collimator fine	TSTWC01002
Set filter in	TSTWC01008
Set filter out	TSTWC01009
Set crystal position +1	TSTWC01010
Set crystal position −1	TSTWC01011
Set scintillation detector off	TSTWC01100
Set scintillation detector on	TSTWC01101
Set flow detector on	TSTWC01103
Set flow detector off	TSTWC01102
Set 1st order	TSTWC01105
Set 2nd order	TSTWC01104
Set "analyse" lamp on	TSTWC01107
Set "analyse" lamp off	TSTWC01106

7.1.11. Spectrometer control 2 bit patterns

	D7							D0
READ C020	vacuum o.k.	gas o.k.	turret* bit B	turret* bit A	plunger LOW	plunger HIGH	cap LOW	cap HIGH
READ C023	card busy	0	0	vacuum busy	helium busy	turret busy	plunger busy	cap busy
WRITE C020	X	X	X	X	X	00=cap UP 01=cap DOWN 10=plunger UP 11=plunger DOWN		OFF=0 ON=1
WRITE C021	X	X	X	X	000 = helium valve 2 001 = helium valve 3 010 = helium valve 4 011 = helium valve 5 100 = helium valve 1			OFF=0 ON=1
WRITE C022	X	X	X	X	000 = vacuum pump 001 = spinner 010 = main air valve 011 = main vacuum valve 100 = airlock air valve 101 = airlock vacuum valve			OFF=0 ON=1
WRITE C023	X	X	X	turret 1 pos. advance	X	X	X	OFF=0 ON=1

*

bit B	bit A	turret measuring position
0	0	3
0	1	2
1	0	1
1	1	4

** on this pcb there is a 10 Hz clock which generates Interrupt 5.

Spectrometer control 2 test commands

Notes 1. This pcb controls the compressed air valves. To obtain a movement of the cap or plunger it is necessary to operate two valves. To avoid damage or misalignment of these mechanisms the valves must be operated in the correct order. That is: first operate the valve which applies pressure in the direction of desired movement and second, operate the valve which is applying pressure in the direction opposing the desired movement.

Cap up OFF	TSTWC02000
Cap up ON	TSTWC02001
Cap down OFF	TSTWC02002
Cap down ON	TSTWC02003
Plunger up OFF	TSTWC02004
Plunger up ON	TSTWC02005
Plunger down OFF	TSTWC02006
Plunger down ON	TSTWC02007
Helium valve 2 OFF	TSTWC02100
Helium valve 2 ON	TSTWC02101
Helium valve 3 OFF	TSTWC02102
Helium valve 3 ON	TSTWC02103
Helium valve 4 OFF	TSTWC02104
Helium valve 4 ON	TSTWC02105
Helium valve 5 OFF	TSTWC02106
Helium valve 5 ON	TSTWC02107
Helium valve 1 OFF	TSTWC02108
Helium valve 1 ON	TSTWC02109
Vacuum pump OFF	TSTWC02200
Vacuum pump ON	TSTWC02201
Spinner ON	TSTCWC02203
Main air valve closed	TSTWC02204
Main air valve open	TSTWC02205
Main vacuum valve closed	TSTWC02206
Main vacuum valve open	TSTWC02207
Airlock air valve closed	TSTWC02208
Airlock air valve open	TSTWC02209
Airlock vacuum valve closed	TSTWC0220A
Airlock vacuum valve open	TSTWC0220B
Sample turret mechanism to next higher numbered position	TSTWC02310

7.1.12. Spectrometer control 3 bit patterns

	D7								D0
READ C031	generator ready	NO sample changer	NO* sample under cap	1	J32 J31	J30 J29	J28 J27	PHDIV+ OFF ON	=0 =1
READ C034	J16	J8	J12	J10	J14	J6	J4	J2	=0
	J15	J7	J11	J9	J13	J5	J3	J1	=1
WRITE C030	X	X	X	0=mA 1 = kV	bit D **	bit C **	bit B **	bit A **	
WRITE C031	X	X	X	X	X	X	X	0=manual generator 1=remote	
WRITE C032	X	X	ASCII bit 6	ASCII bit 5	ASCII bit 4	ASCII bit 3	ASCII bit 2	ASCII bit 1	
WRITE C033	X	X	X	X	0=0000=display BLANK 1=0001=display NOT BLANK 8=1000=display digit 1 9=1001=display digit 2 A=1010=display digit 3 B=1011=display digit 4 C=1100=display digit 5 D=1101=display digit 6				

display

1	2	3	4	5	6

* when sample changer is fitted

** kV and mA selection

Spectrometer control 3 test commands

Select kV	25	TSTWC03010
	30	TSTWC03011
	35	TSTWC03012
	40	TSTWC03013
	45	TSTWC03014
	50	TSTWC03015
	55	TSTWC03016
	60	TSTWC03017
	65	TSTWC03018
	70	TSTWC03019
	75	TSTWC0301A
	80	TSTWC0301B
	85	TSTWC0301C
	90	TSTWC0301D
	95	TSTWC0301E
	100	TSTWC0301F
Select mA	10	TSTWC03000
	15	TSTWC03001
	20	TSTWC03002
	25	TSTWC03003
	30	TSTWC03004
	35	TSTWC03005
	40	TSTWC03006
	45	TSTWC03007
	50	TSTWC03008
	55	TSTWC03009
	60	TSTWC0300A
	65	TSTWC0300B
	70	TSTWC0300C
	75	TSTWC0300D
	80	TSTWC0300E
	85	TSTWC0300F
Generator manual		TSTWC03100
Generator remote		TSTWC03101

Display characters (ASCII)

Character	Hexadecimal
α	00
A	01
B	02
C	03
D	04
E	05
F	06
G	07
H	08
I	09
J	0A
K	0B
L	0C
M	0D
N	0E
O	0F
P	10
Q	11
R	12
S	13
T	14
U	15
V	16
W	17
X	18
Y	19
Z	1A
`	1C
a	1D
β	1E
γ	1F
blank	20
(a-r)	21
''	22
(a-g)	23
$	24
%	25
(h-r)	26
'	27
<	28
>	29
*	2A
+	2B
–	2D
/	2F
0	30
1	31
2	32
3	33
4	34
5	35
6	36
7	37
8	38
9	39
≤	3A
≥	3B
<	3C
=	3D
>	3E
	3F

Character	TSTWC032xx	(xx = hexadecimal code for character)
Display blank	TSTWC03300	
Display not blank	TSTWC03301	
Display digit 1	TSTWC03308	
Display digit 2	TSTWC03309	
Display digit 3	TSTWC0330A	
Display digit 4	TSTWC0330B	
Display digit 5	TSTWC0330C	
Display digit 6	TSTWC0330D	

In order to be able to display a character it is first necessary to activate the display. This can be done either by setting a channel (e.g. SCH CU) or by writing a program into the RAM, and in order to do this the free space in the RAM must be more than 18.

The following typical program may be used:

```
TSTW47EE  3E   02  32  32  C0  3E  0A   32  33  C0  3E  01  32  33
          C0   C3  FD  47
```

The test is started by typing TSTE47EE CR.

The above program, which causes the character "B" to be displayed in the "digit 3" position, must be modified to display other characters and other digits. The program is constructed as follows:

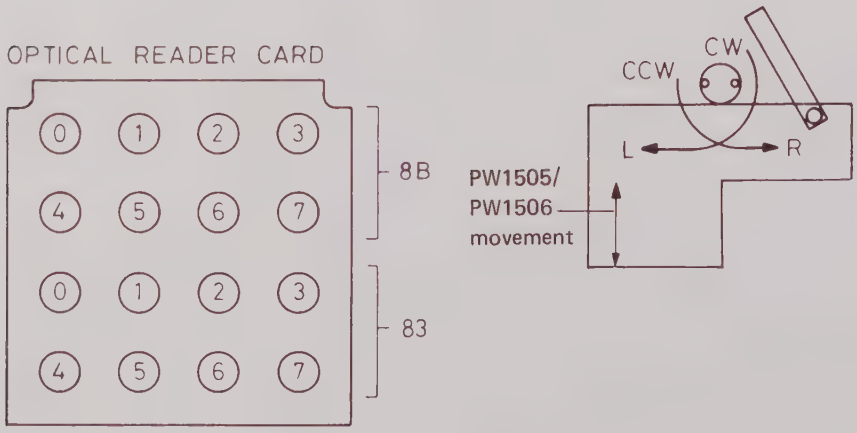
Address	Machine Code	Label	Mnemonic	Comment
47EE	3E42	DISP	MVI A, 02	Load accumulator with ASCII character "B"
	32 32 C0		STA C0, 32	Character to pcb address
	3E 0A		MVI A, 0A	Load accumulator with digit address
	32 33 C0		STA C0, 33	Digit address to pcb
	3E 01		MVI A, 01	Load accumulator with "display on"
	32 33 C0		STA C0, 33	"Display on" to pcb
47FD	C3 FD47	WAIT	JMP 47FD	Wait loop – Keeps display on

See also Chapter 7.4.4.

7.1.13. Sample loader control bit patterns (PW 1500/00/05/06, PW1505, PW1505, PW1506)

READ C083* (optical reader lower half)	bit 8	bit 4	bit 2	bit 1	bit 8	bit 4	bit 2	bit 1
	Tray no. Tens (BCD)				Tray no. Units (BCD)			
READ C087	sample in pick-up position	1 PW1505 Yes = 1 PW1506 Yes = 0	1 PW1505 Yes = 0 PW1506 Yes = 0	arm in rest	arm HIGH	arm in spectr.	arm LOW	arm in sample loader
READ C08B* (optical reader upper half)	0 = X 1 = Mon.	bit 4	bit 2	bit 1	bit 8	bit 4	bit 2	bit 1
		Progr. No. Tens (BCD)			Progr. No. Units (BCD)			
READ C08D	card busy	arm vert. busy	reference tray busy	arm hor. busy	drive disc rear busy	reference tray busy	sample loader not connected	0
READ C08F	reference tray in rest posn.	drive disc rear in rest	1	tray ms left rear	reference tray in load posn.	0	1	tray ms centre rear
WRITE C087	sample loader OFF	X	arm hor. LOAD	X	X	arm hor. UN-LOAD	arm vert.	sample loader ON
WRITE C08F	reference tray to loading position	reference tray to rest position	X	drive disc rear counter clockwise	drive disc rear clock-wise	X	X	X

* optical reader card



Sample loader control test commands

Sample loader ON	TSTWC08701
Sample loader OFF	TSTWC08780
Loading arm vertical move	TSTWC08702
Loading arm horizontal unload	TSTWC08704
Loading arm horizontal load	TSTWC08720
Rear tray drive disc clockwise rotate	TSTWC08F08
Rear tray drive disc counter clockwise rotate	TSTWC08F10
Reference tray to loading position	TSTWC08F80
Reference tray to rest position	TSTWC08F40

7.1.13.1. Sample changer control bit patterns (PW1500/10/15/16)

READ C083* (optical reader lower half)

bit 8	bit 4	bit 2	bit 1	bit 8	bit 4	bit 2	bit 1
Tray no. Tens (BCD)				Tray no. Units (BCD)			

READ C087

sample in pick-up position	0	1	arm in rest	arm HIGH	arm in spectr.	arm LOW	arm in sample changer

READ C08B* (optical reader upper half)

0 = X 1 = Mon.	bit 4	bit 2	bit 1	bit 8	bit 4	bit 2	bit 1
	Progr. No. Tens (BCD)			Progr. No. Units (BCD)			

READ C08D

card busy	arm vert. busy	belts busy	arm hor. busy	drive disc rear busy	drive disc front busy	sample changer not connected	0

READ C08F

drive disc front in rest	drive disc rear in rest	tray ms centre front	tray ms left rear	tray ms left front	tray ms right rear	tray ms right front	tray ms centre rear

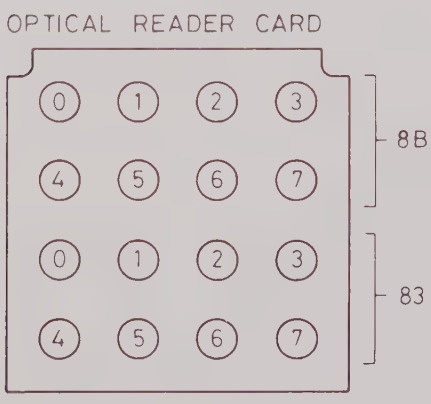
WRITE C087

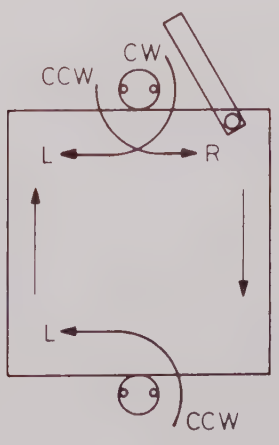
sample changer OFF	X	arm hor. LOAD	X	X	arm hor. UN-LOAD	arm vert.	sample changer ON

WRITE C08F

belts clock-wise	drive disc front counter clockwise	X	drive disc rear counter clockwise	drive disc rear clock-wise	X	X	X

* optical reader card





RD3703

Sample changer control test commands

Sample changer ON	TSTWC08701
Sample changer OFF	TSTWC08780
Loading arm vertical move	TSTWC08702
Loading arm horizontal unload	TSTWC08704
Loading arm horizontal load	TSTWC08720
Rear tray drive disc clockwise rotate	TSTWC08F08
Rear tray drive disc counter clockwise rotate	TSTWC08F10
Front tray drive disc counter clockwise rotate	TSTWC08F40
Transport belts clockwise	TSTWC08F80

Information about Herzog sample changers together with bit patterns and test commands is given in a separate publication PW1502/00/40/60, Sample Changer ROM and Interfacing Instruction Manual (ordering code 9499 303 00411).

7.2. START-UP TESTS

7.2.1. Test procedure

Each time the spectrometer is switched on, and when the RESET pushbutton is pressed, the microprocessor automatically carries out a test procedure and prints out the results via interface 1.

The test procedure is as follows:

Description	*Command*
1. disable all interrupts	
2. Switch on ANALYSE lamp	
3. Program USARTs on serial interfaces 1 and 2	/07 to address /C011
4. Send "*" to terminal 1	/2A to address /9000
5. Switch-off ANALYSE lamp	/06 to address /C022
6. Fill the stack area in the RAM (50 bytes) with 50,49 02,01	
7. Read back the contents of the stack and test. For each error found, print "E"	/45 to address /9000
8. Print "*" after the stack area has been tested.	/2A to address /9000

Note: Up to this point information has been sent to the peripheral irrespective of the presence or absence of handshake signals between the peripheral and Interface No. 1. For the test to continue successfully, correct handshake signals must be present.

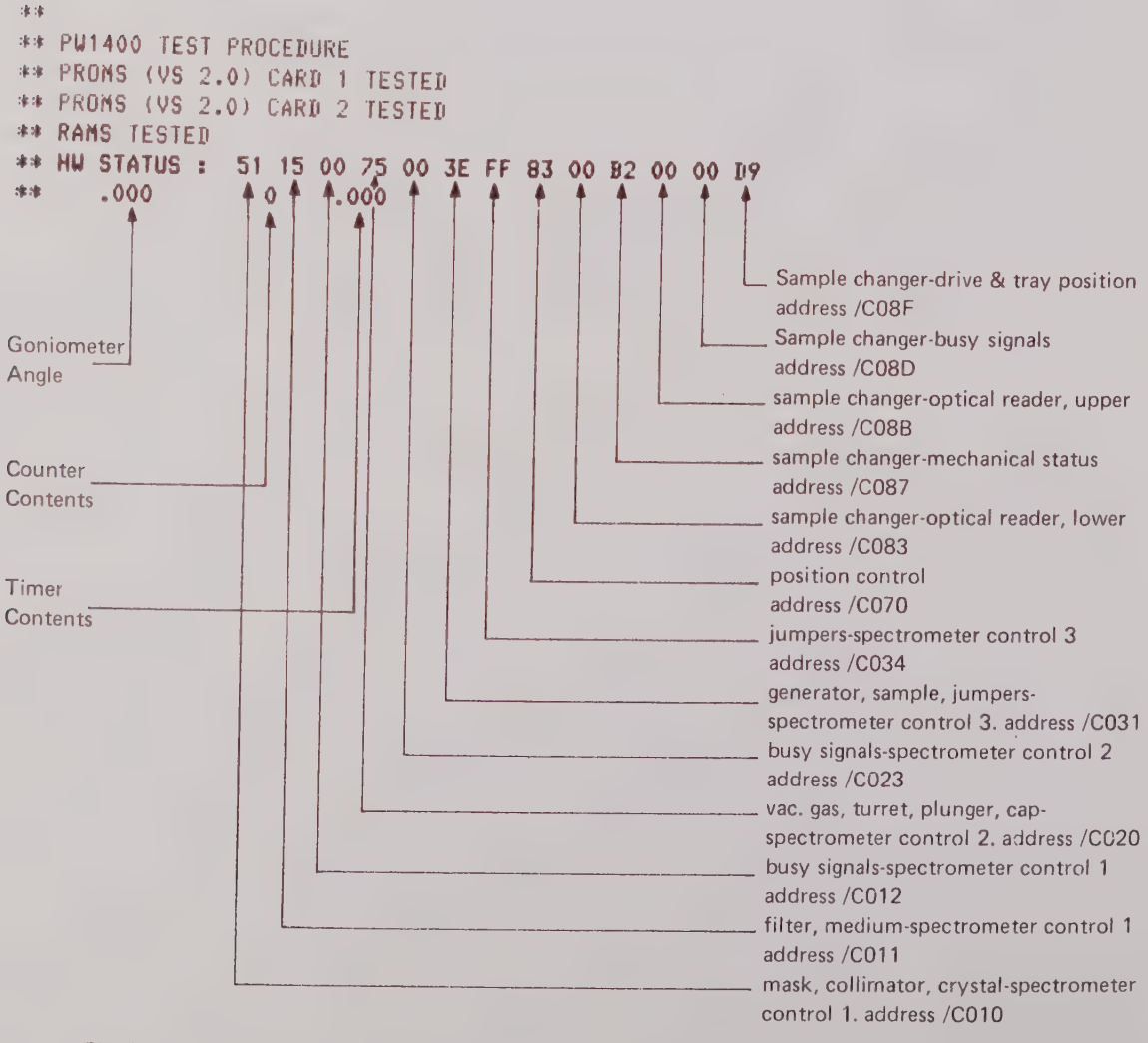

**
** PW1400 TEST PROCEDURE
** PROMS (VS 2.0) CARD 1 TESTED
** PROMS (VS 2.0) CARD 2 TESTED
** RAMS TESTED
** HW STATUS : 51 15 00 75 00 3E FF 83 00 B2 00 00 D9
** .000 0 .000
Goniometer Angle
Counter Contents
Timer Contents
Sample changer-drive & tray position address /C08F
Sample changer-busy signals address /C08D
sample changer-optical reader, upper address /C08B
sample changer-mechanical status address /C087
sample changer-optical reader, lower address /C083
position control address /C070
jumpers-spectrometer control 3 address /C034
generator, sample, jumpers-spectrometer control 3. address /C031
busy signals-spectrometer control 2 address /C023
vac. gas, turret, plunger, cap-spectrometer control 2. address /C020
busy signals-spectrometer control 1 address /C012
filter, medium-spectrometer control 1 address /C011
mask, collimator, crystal-spectrometer control 1. address /C010

Fig. 7.2.1. Normal start-up test procedure print out.

9. Using print subroutines (for which the stack is required) print (VDU or printer must be ready)
"** PW1400 TEST PROCEDURE"

   Note: The software version number may vary from VS 2.0.

10. Calculate the "checksum" of each PROM (on the CPU pcb) and compare this with the checksum stored in PROM0.

    If not equal print:
    "** ERROR PROM N CHSC"
    where N = PROM number (0 ... 7)
    CHSC = CALCULATED CHECKSUM

    After this step print:
    "** PROMS (VS 2.0) CARD 1 TESTED"

    Note: For this part of the test routine to be correctly executed, the areas in PROM 0 and PROM 7 where the test program is stored must be correct.

11. (a) Check if second PROM card (PW1502/00) is fitted, by checking the contents of addresses 6000 and 6001 — these must be /FF and /00 respectively.
    (b) Check contents of address 6002 — this must be
    100 for Philips sample changers
    101 for Herzog sample changers.
    (c) For Philips sample changers, calculate "checksum" of PROMS 8, 9 and 10, and compare this with checksum stored in PROM 8.
    If not equal print:
    "** ERROR PROM N CHSK"
    where W = PROM number (8 ... 10)
    CHSK = calculated checksum.
    After this step print:
    "** PROMS (VS 2.0) CARD 2 TESTED"
    (d) For Herzog sample changers, calculate checksum of PROMS 8 and 9, and compare this with checksum stored in PROM 8.
    If not equal print:
    "** ERROR PROM N CHSK"
    where N = PROM NUMBER (8 or 9)
    CHSK = calculated checksum.
    After this step print:
    "** PROMS (HERZOG VS 2.0) CARD 2 TESTED".

12. The original information in each RAM location is stored in turn in a microprocessor register. Then the words /AA (1010 1010) and /55 (0101 0101) are written successively into the RAM location, read back, and compared to check that the code read back is the same as the code that was written in. /AA to each address
    Before each location is tested, the contents of the locations before and after the location being tested are added together and stored in a register. After the original data have been written back into the test location to contents of the locations before and after this are subtracted from the sum previously stored. The result must equal 0. If result is not 0, an error message is printed. This part of the test ensures that the contents of the locations before and after a location being tested are not affected by writing into that location.

After each location has been tested in this way the contents of the last location in the RAM is tested to ensure that its contents have not changed. This part of the test ensures that testing one location has not caused the contents of each of the following locations to be moved to the next location.

The number of locations tested per RAM is also maintained in a register. After 255 locations have been tested the data in the last location will be changed. This condition is tested, ensuring that RAM address decoder is also functioning correctly.

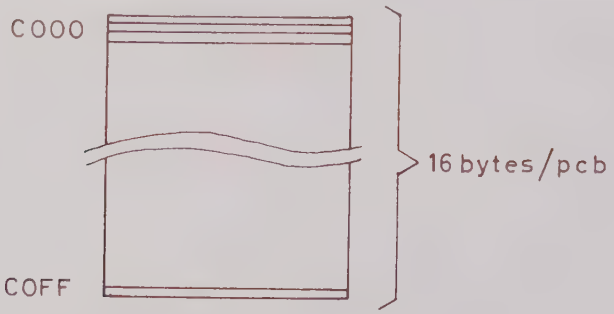
If an error is found during this test, print the following:
"** ERROR RAM I CODE AAAA CC EC".

where:

I = number of RAM pair
AAAA = address being tested
CC = test code (/AA or /55)
EC = ending code
1 = last RAM address not correct
2 = input code ≠ output code
3 = decoder error (on RAM) (contents of last RAM address not changed after 255 test cycles)
4 = address before or after the test address has been affected
5 = decoder error (on RAM) (contents of last RAM address changed too early)

After the RAM test print:
"** RAMS TESTED"

13. Print the status of the spectrometer bus



The following locations are printed:

Location	*Parameter*
/C010	Mask, collimator, crystal (spectrometer control 1)
/C011	Filter, vacuum, helium, air (spectrometer control 1)
/C012	Busy lines (spectrometer control 1)
/C020	Cap, plunger, sample turret, detector gas, vacuum (spectrometer control 2)
/C023	Busy lines for cap, plunger, sample turret (spectrometer control 2)
/C031	Generator, sample, jumpers (spectrometer control 3)
/C034	Jumpers (spectrometer control 3)
/C070	Status of position control

/C083	Sample changer-optical reader lower
/C087	Sample changer-mechanical status
/C08B	Sample changer-optical reader upper
/C08D	Sample changer-busy lines
/C08F	Sample changer-drive and tray positions
/C071	2θ angle, decade 0
/C072	2θ angle, decade 1
/C073	2θ angle, decade 2
/C074	2θ angle, decade 3
/C075	2θ angle, decade 4
/C076	2θ angle, decade 5
/C060	Counter, decade 0
/C061	Counter, decade 1
/C062	Counter, decade 2
/C063	Counter, decade 3
/C064	Counter, decade 4
/C065	Counter, decade 5
/C066	Counter, decade 6
/C067	Counter, decade 7
/C06F	Timer, decade 0
/C06E	Timer, decade 1
/C06D	Timer, decade 2
/C06C	Timer, decade 3
/C06B	Timer, decade 4
/C06A	Timer, decade 5

14. (a) Set VAH (vacuum/air/helium) to neutral.
    (b) Clear the display.
    (c) Drive the cap and the plunger in the original directions.
    (d) Set vacuum pump and helium system on.
    (e) Initiate VAH setting.
    (f) Reset sample changer.
    (g) Clear the input buffer.

15. Test the RAM locations /40D6 and /40D7, which must contain /FF and /00 respectively.
    This data can be lost if:
    (a) Power is disconnected from the spectrometer and the battery back-up is switched off.
    (b) The RAM pcb has been removed from the spectrometer.
    (c) The bus interface pcb has been removed from the spectrometer.

    This test checks if information is correctly retained in the RAM. If the contents of the RAM locations are not correct then:
    (d) Clear RAM (write /00 in all locations).
    (e) Write /FF and /00 into locations
        /40D6 and /40D6 respectively.
    (f) Set helium time to 6 seconds.
    (g) Set vacuum time to 3 seconds.
    (h) Print "** ERROR BATTERY, PARAMETER BANK CLEARED".

16. (a) Stop counter/timer.
    (b) Set chart recorder off.
    (c) Reset interrupts.
    (d) Switch on ANALYSE lamp.

17. Enable interrupts:

Keyboard	(INTR7)
Timer (timer interrupt interval 0.1 s)	(INTR5)
Spectrometer control	(INTR4)
Counter-timer	(INTR3)
Position control	(INTR2)

18. After delay of 0.5 s (count 5x 0.1 s interrupt pulse from counter/timer via spectrometer control 2) switch off "ANALYSE" lamp and spinner and print "C=". and wait for operator's input.

7.2.2. Check for microprocessor operation

It is possible to check very simply that the microprocessor is running. This can be done using the start-up test procedure and a double-beam oscilloscope.

In the microprocessor software program, the microprocessor must perform nine read operations between the printing of the first two asterisks in the start-up procedure. Connect the two oscilloscope inputs to the pins 17 (DBIN) and 18 (WR) on the 8080A.

Each time the RESET pushbutton is pressed, the pattern of pulses shown in fig. 7.2.2. should be seen.

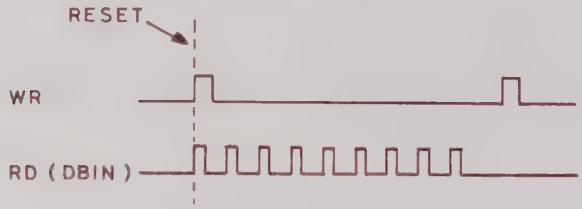


Fig. 7.2.2. Pulse diagram for µP start up

7.2.3. Microcomputer test and status readout

The microcomputer can be tested and the status printed without resetting the spectrometer system by giving the test command TST U. This results in the same printout as is given in chapter 7.2.1.

7.3. ERROR MESSAGES

7.3.1. Introduction

During programming, parameter setting, and measurement, the microcomputer can generate various error messages. Error messages generated by the microcomputer software are prefixed with two asterisks "**", while those generated by the minicomputer software are prefixed with three asterisks "***". The error messages listed in this chapter are based on microprocessor software version 2.0. Earlier versions of the software should no longer be in use.

7.3.2. Error message generated during program MC preparation

ERROR MESSAGE	MEANING
** ERROR COMMAND NOT AVAILABLE	Incorrect command given, not in microprocessor software.
** INVALID ARGUMENT	Argument not correct or incomplete. Repeat command with proper argument.
** INVALID, CORRECT VALUE (S) =	Incorrect value entered during list assembly, and will require the correct value to be input before the list assembly can proceed.
** MP . . . ** NOT IN MEMORY	Requested measurement parameters list not assembled and stored in the memory, e.g. when requested by SMX.
** NOT IN MEMORY	Requested channel set or MP list has not been assembled.
** NO MORE SPACE AVAILABLE	The maximum (63) channel sets have already been assembled in the parameter bank.
** LIST OVERFLOW	MP list or job list is more than 255 bytes.
** MEMORY OVERFLOW	Too many MP lists and job lists in the parameter bank.
** ERROR > 80 CHAR	Any line of operator typed characters (command, arguments, spaces, identification, etc.) must be less than 80 before carriage return is given.
** ERROR WRONG CHAR AFTER /CR LF: =	Character given in a stop command is not correct (can be S, M or T).
** ERROR F2	During "read parameter bank", the number of characters/line ≠ 71.
** ERROR F3	During "read parameter bank", the data bank being read is greater than the available memory (RAM) space.
** ERROR F4	During "read parameter bank", a non-hexadecimal code is read.
** ERROR F8	During assembly of a measuring programme, the number of channels is made < 0 by deleting more channels than were originally present.

7.3.3. Error messages generated during start-up procedure

** ERROR PROMN CHSK	An incorrect checksum (CHSK) is found during the test of PROM N.
** ERROR RAM I CODE AAAA CC EC	An incorrect testcode (CC) is found at address AAAA during test of RAM I. EC = Ending code.
** ERROR BATTERY, PARAMETER BANK CLEARED	Parameter bank cleared, owing to either the RAM pcb or the bus interface pcb having been removed, or to the power having been disconnected with the battery switched off.

7.3.4. Error messages generated during sample loading

ERROR MESSAGE	MEANING
** GENERATOR OFF	Given when a program or command requests generator settings (not manual) but the H.T. is switched off.
** NOT ALLOWED IN POSITION X	Output if LDM2 is given in continuous mode (CMD) or if sample changer is in the –x–x (SCM2) or –xxx (SCM3) mode, or if LDM3 is given with sample changer in –xxxx (SCM3) mode.
** ERROR MONITOR LOADED IN POSITION X	Attempt to load an unknown sample into a turret position that contains a monitor. Either unload the monitor first with the ULM command, or load the unknown into another turret position.
** ERROR NO MONITOR IN POSITION X	Monitor sample has not been loaded (by LDM command) in the MOPS turret position.
** NO BUF. RAT	The measurement program selected by a SMM command is for absolute or direct ratio measurement, i.e. not buffer ratio.
** ERROR PRINTER 2	Output to a second device is requested (SOT Y) but connection to device is not present. Output is not inhibited (output will only appear at the main terminal).
** ERROR MONITOR	No sample in position 1 in sample changer tray when program calls for monitor.

7.3.5. Error messages generated during measurement

All mechanical parameters apart from goniometer angle and sample turret have two stable positions. These positions are detected by the microcomputer when a microswitch is actuated. Thus a change in a parameter involves the release of one microswitch (in the starting position) and the actuating of another microswitch (in the end position).

Each mechanical action requires time to complete, and this must be allowed for in the microcomputer software. The software also provides guarding of the mechanical parameters i.e., if the parameter is not set within a predetermined time the program is stopped and an error message is printed.
The guarding of the cap movement is given as an example in figure 7.3.5.

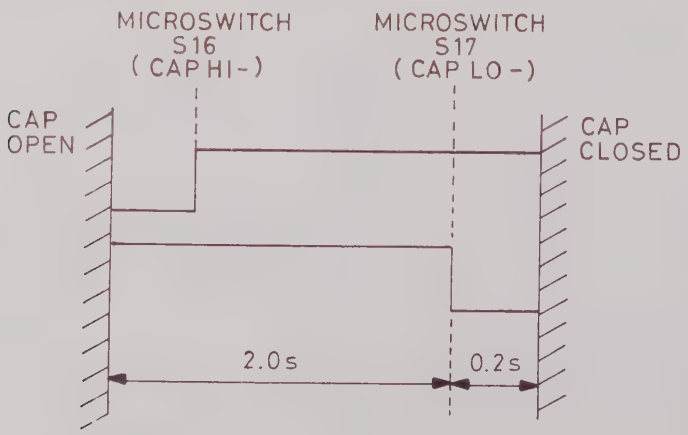


Fig. 7.3.5. Guarding of mechanical parameters (cap unit as example).

Suppose that a movement from "cap open" to "cap closed" is required, the following actions will be carried out:

1. Start action "cap open" ⇒ "cap closed".
2. Set maximum timer in software. E.g. for the cap movement this is 3.0 s.
3. Wait for CAPLO– = 0 (microswitch S17 actuated).
4. If CAPLO– = 0 within 3.0 s maximum, then:
   (a) Reset maximum timer.
   (b) Set delay timer to 0.5 s.
   After the 0.5 s delay, start the counter timer, etc.
5. If CAPLO– = 1 (microswitch S17 not actuated) after the 3.0 s maximum time, print:
   "** ERROR CAP".

A similar guarding routine with suitable maximum times, is used for all mechanical parameters.
Thus, if the microswitch indicating that a parameter has been set is not actuated within the predetermined time an error message will be printed, and the program will be stopped.

The following error messages may be printed:

ERROR MESSAGE	MEANING
** ERROR COLLIMATOR	Requested collimator not in position within 3.0 seconds.
** ERROR FILTER	Requested filter position not reached within 3.0 seconds.
** ERROR MASK	Requested mask not in position within 3.0 seconds.
** ERROR CRYSTAL	Requested crystal not in position within time based on 3.0 seconds per crystal position (maximum 3x3.0 seconds)
** ERROR CAP	Requested cap position not reached within 2.0 seconds.
** ERROR PLUNGER	Requested plunger position not reached within the following times plunger down – 3.0 seconds plunger up – 2.0 seconds
** ERROR TURRET	Requested turret position not reached within 15.0 seconds.

In addition, the following error messages may be generated:

** ERROR DETECTOR GAS	Printed if difference in flowrate between the input and the output of the gas flow detector > 6 l/hr.
** ERROR MEDIUM	One of the pushbuttons VACUUM/HELIUM/AIR is not depressed. Operation is not inhibited.
** ERROR VACUUM	Hardware indicates a pressure higher than 30 Pascal
** ERROR	Correct angle limit not reached during scanning or Character transmit (CTS signal) error from peripheral.
** ERROR F1	Interrupt 1 detected (interrupt 1 is, in practice, not connected).
** ERROR F7	Selected goniometer is $< 0^{o}$ or $> 147,005^{o}2^{o}$. Can be caused by setting a channel containing 0^{o} together with a negative offset angle or 147^{o} together with a positive offset angle.
** ERROR FRAMING	The detected number of bits per character is not correct (stop-bit not detected by USART). Can be the result of wrong baud-rate setting.
** ERROR OVERRUN	A character in the I/O buffer of the USART has not been fetched by the microprocessor by the time the next character is ready to be loaded. The character is then lost.
** ERROR PARITY	A parity error is detected by the USART.

7.3.6. Error messages generated when a sample changer/loader is in use.

ERROR MESSAGE	MEANING
**ERROR SAMPLE CHANGER,CODE 02	Sample changer not connected.
** ERROR SAMPLE CHANGER, CODE 04	Front trayshift motor not in rest position within predetermined time.
** ERROR SAMPLE CHANGER, CODE 08	Spectrometer-side trayshift motor not in rest position within predetermined time.
** ERROR SAMPLE CHANGER, CODE 10	Horizontal grab motor not in rest position within predetermined time.
** ERROR SAMPLE CHANGER, CODE 20	No sample tray detected within predetermined time.
** ERROR SAMPLE CHANGER, CODE 24	Reference tray not moved into correct position.
** ERROR SAMPLE CHANGER, CODE 40	Vertical grab motor not in rest position within predetermined
** ERROR SAMPLE CHANGER, CODE E0	Tray shift at front not in rest position.
** ERROR SAMPLE CHANGER, CODE E1	Tray transport microswitch S14, not actuated after ·7 revolutions of front trayshift.
** ERROR SC NOT CONNECTED	Sample changer control pcb not in position in PW 1400/00.
** ERROR SAMPLE CHANGER, CODE F1	Cap not open when grab horizontal movement demanded.
** ERROR SAMPLE IN SPECTROMETER	Sample already in loading position when load command given by microprocessor.
** ERROR NO SAMPLE IN SPECTROMETER	No sample in loading position when unload command given by microprocessor or No sample in loading opening after loading action completed.
** ERROR FRT/SRT MOVEMENT NOT POSSIBLE	Reference tray movement not possible after commands FRT or SRT given.
** ERROR SAMPLE IN SAMPLE CHANGER	Sample already in tray before unloading action started.
** ERROR NO SAMPLE IN SAMPLE CHANGER	No sample in tray when load command given by microprocessor or No sample in tray after unloading action completed.
** ERROR SAMPLE CHANGER, CODE F7	Grab in loading position when cap close command given by microprocessor.
** ERROR SAMPLE CHANGER, CODE F8	Trayshift at spectrometer side not in rest position.
** ERROR SAMPLE CHANGER, CODE F9	Grab not in rest position.
** ERROR NO TRAY	No tray in centre position at spectrometer side (microswitch S11 not actuated).
** ERROR SAMPLE CHANGER, CODE FB	Tray left-to-right movement at spectrometer side demanded by microprocessor when microswitch S13 still actuated.
** ERROR SAMPLE CHANGER, CODE FC	Tray right-to-left movement at spectrometer side demanded by microprocessor when microswitch S15 still actuated.
** ERROR SAMPLE CHANGER, CODE FD	No tray or wrong tray in sample loader when commands FRT or SRT are given.
** ERROR SAMPLE CHANGER, CODE FE	No monitor option fitted in sample loader when commands FRT or SRT are given.
** ERROR SAMPLE CHANGER, CODE FF	Microswitches S11 and S15 not actuated when microprocessor gives command to read optical reader.

7.4. TEST PROCEDURES BASED ON MICROPROCESSOR INSTRUCTION SET

In principle it is possible to write microprocessor programs for the PW 1400/00 using any of the instructions available in the 8080A instruction set. A copy of this instruction set appears at the end of this section of the chapter. Programming must be done in 8080A machine code, which can be input in the form of 16-bit (hexadecimal) characters. To make full use of this facility a course on microprocessors and microprocessor programming would be required. However this chapter section includes three practical programs which are explained in some detail. A good understanding of these should enable the service engineer to use them and to adapt then for measurements on other parameters.

7.4.1. Use of RAM

The software for the microprocessor is contained in PROMs and cannot be modified via the peripheral keyboard, but the RAM, which is used during program execution, can be addressed via the keyboard. However, most locations are used for the parameter bank, so if this is not to be lost care must be exercised in choosing a RAM area which can be used for storing locally written programs.

For most purposes it is usually best to use the area of memory between the addresses /47B0 and /47FF. This area is normally used to store programmed tray information for the sample changer, and since this information will be changed at frequent intervals its loss will not cause any difficulty. If it is desired to use another part of the RAM it should be remembered that part of the data bank/parameter bank will be destroyed.
If a computer is connected the parameter bank could first be dumped onto floppy disc, for instance.

The contents of the chosen memory area can also be displayed (or printed) with the aid of a test command. e.g. TST R 47B0 0050 CR (i.e. 82 bytes).

7.4.2. Example 1. Plunger timing

In the plunger movement cycle four, possible measurements could be made. These are illustrated in fig. 7.4.2.1. The program to be outlined measures the time taken for the plunger to travel between the point at which the microswitch S14 is released (PLUHI– = 1) and the point at which the microswitch S15 is operated (PLULO– = 0). This is represented by the distance "B" in figure 7.4.2.1.

The program is shown in flow chart form in fig. 7.4.2.2. It can be described in the following steps:

1. Command plunger high – this involves switching valves Y14 on and Y2 off (in this order). This is the starting condition for the measurement.
2. Wait until the microswitch S14 is actuated i.e. PLUHI– = 0.
3. Command plunger low – this involves switching valves Y2 on and Y14 off (in this order).
4. Wait until microswitch S14 is released i.e. PLUHI– = 1.
5. Start counter/timer.
6. Wait until microswitch S15 is actuated i.e. PLULO– = 0.
7. Stop counter/timer.
8. Call software print routine (in PROM) and print out 2θ angle, counts, and time.
9. Return.

The program carries out one cycle of plunger movement and prints the results.

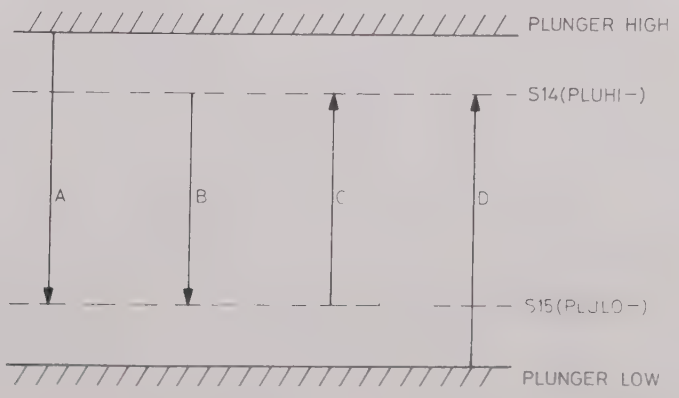


Fig. 7.4.2.1.

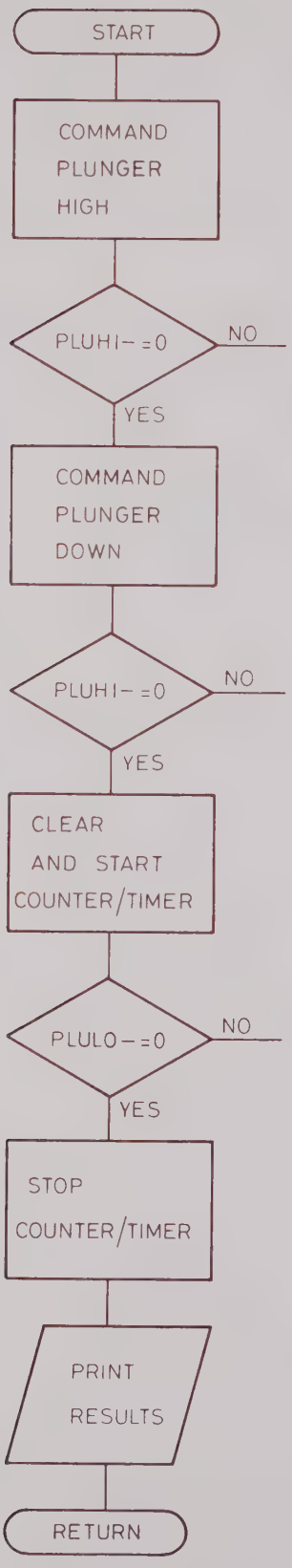


Fig. 7.4.2.2. Plunger timing flow chart-distance "B"

ADDRESS	MACHINE CODE	LABEL	MNEMONIC		COMMENT
/47B0	3E 05	PLUTIM	MVI	A, /05	Valve Y14 on
	32 20 C0		STA	/C0 /20	
	3E 06		MVI	A, 06	Valve Y2 off
	32 20 C0		STA	/C0 /20	
/47BA	3A 20 C0	LOOP1	LDA	/C0 /20	Wait for PLUH1– = 0
	E6 04		ANI	/04	
	CA BA 47		JZ	LOOP1	
/47C2	3E 07		MVI	A, /07	Valve Y2 on
	32 20 C0		STA	/C0 /20	
	3E 04		MVI	A, /04	Valve Y14 off
	32 20 C0				
/47CC	3A 20 C0	LOOP2	LDA	/C0 /20	Wait for PLUH1– = 1
	E6 04		ANI	/04	
	C2 CC 47		JNZ	LOOP2	
/47 D4	3E 4E		MVI	A, /4E	Reset counter/timer
	32 68 C0		STA	/C0 /68	
	3E 01		MVI	A, /01	Start counter/timer
	32 68 C0		STA	C0 /68	
/47 DE	3A 20 C0	LOOP3	LDA	/C0 /20	Wait for PLUL0– = 0
	E6 08		ANI	/08	
	CA DE 47		JZ	LOOP3	
/47E6	3E 02		MVI	A, /02	Stop counter/timer
	32 68 C0		STA	/C0 /68	
	CD 5D 0E (*)		CALL	Print routine	Print: 2θ/counts/time
	C9		RET		Return

Fig. 7.4.2.3. Plunger timing program - distance "B".

(*) Address of print subroutine (in 8080 format, least significant byte first)

in software version 1.4 = 4D 0C
in software version 1.5 = 93 0C

NOTE

Where an two data characters or an address must be entered as part of an instruction the least significant bytes must be entered first i.e. in reverse order.
For example, the instruction LDA /C0 /20 is entered as 3A 20 C0 (see fig. 7.4.2.2.).

The program is shown completely in fig. 4.7.2.3. It can be entered into the RAM by typing the following:

```
TSTW 47B0 3E 05 32 20 C0 3E 06 32 20 C0 3A 20 C0 E6 04 CA
TSTW 47C0 BA 47 3E 07 32 20 C0 3E 04 32 20 C0 3A 20 C0 E6
TSTW 47D0 04 C2 CC 47 3E 4E 32 68 C0 3E 01 32 68 C0 3A 20
TSTW 47E0 C0 E6 08 CA DE 47 3E 02 32 68 C0 CD 5D 0E C9 00 (*)
TSTW 47F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

The contents of the RAM can be checked by typing:
TST R 47B0 0050 CR when the following four lines should be displayed or printed:

```
47B0 3E 05 32 20 C0 3E 06 32 20 C0 3A 20 C0 E6 04 CA
47C0 BA 47 3E 07 32 20 C0 3E 04 32 20 C0 3A 20 C0 E6
47D0 04 C2 CC 47 3E 4E 32 68 C0 3E 01 32 68 C0 3A 20
47E0 C0 E6 08 CA DE 47 3E 02 32 68 C0 CD 5D 0E C9 00 (*)
47F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

* The address of the print subroutine (shown in the printouts as 93 0E) depends on the software version, i.e.:

version 2.0 = 5D 0E
version 1.5 = 93 0C
version 1.4 = 4D 0C

The program can now be started by typing:

TST E 47B0 CR

after which the results will be displayed or printed in the following format:

.000	0	.755
2θ angle	counts	time

If it is desired to repeat the program a number of times, this can be done by typing:

TST CE 47B0 CR

after which the program will be repeated continuously and a column of results will be printed:

The program can now be started by typing:

TST E 47B0 CR

after which the results will be displayed or printed in the following format:

2θ angle	counts	time

If it is desired to repeat the program a number of times, this can be done by typing:

TST CE 74B0 CR

after which the program will be repeated continuously and a column of results will be printed:

.000	0	.783
.000	0	.789
.000	0	.789
.000	0	.788
.000	0	.784
.000	0	.783
.000	0	.792
.000	0	.790
.000	0	.788
.000	0	.791
.000	0	.791
.000	0	.791
.000	0	.791
.000	0	.791
.000	0	.790
.000	0	.791
.000	0	.794
.000	0	.792
.000	0	.793
.000	0	.792
.000	0	.791
.000	0	.793
.000	0	.791
.000	0	.792
.000	0	.794
.000	0	.793
.000	0	.794
.000	0	.794
.000	0	.793
.000	0	.792
.000	0	.799

When sufficient results have been obtained the program can be stopped by typing:

/ CR

This type of program could be written for checking the actual time taken to set any mechanical parameter, or to check the spread of the timing by collecting a large number of measurements. For this purpose the program described here could be modified by substituting the memory-mapped I/O addresses of appropriate microswitches or other signals related to the setting of parameters (see Chapter 7.1.).

7.4.3. Example 2. Microswitch contact bounce

The usual method of measuring and recording switch contact bounce is with a storage oscilloscope. Not only does this require patience and a certain amount of luck, but it involves opening the spectrometer, after which a relatively long period of restabilization is required. However, since the PW 1400/00 contains a microprocessor, contact bounce can be measured with the aid of a suitable program.

The program to be described must form part of a program resulting in a parameter setting in which the microswitch to be investigated is actuated. In this example the program is combined with the plunger timing program in Chapter 7.4.2. so that the contact of microswitch S15 (PLULO– = 0) can be investigated.

The program is designed to sample the memory-mapped I/O address containing the status of the microswitch (in this case /C0 20). 128 samples are taken over a period of 2.56 ms after the actuation of the microswitch is first detected. The results are stored in 128 successive addresses in the RAM, which can be printed out on command. If no contact bounce is detected the contents of all 128 addresses will be the same. Any differences in the address contents indicates contact bounce. The form of the contact bounce can be deduced from the address contents, since these are entered sequentially at intervals of 20 μs.

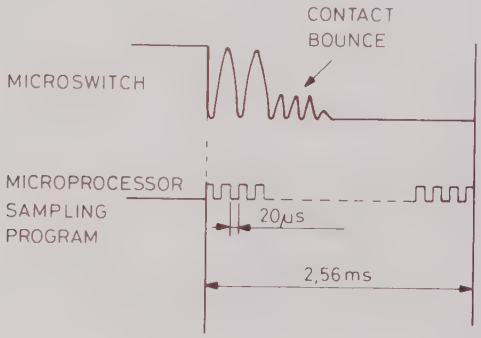


Fig. 7.4.3.1. Microswitch contact bounce (typical).

Since this program requires 128 addresses for storage of the results in addition to /5 addresses for the program itself, care must be taken to choose an unused RAM area if possible. By giving the command PPB CR the contents of the parameter bank (RAM) will be printed, together with a statement of the free spare available.

For example:

```
C=PPB

SI  FE  CU  MN  SN  NI  CO  CR

MP  1
MP  2
MP  3
MP  4
MP 10
MP 12
MP 20
JB 15
JB 50
FREE SPACE :  782 WORDS
```

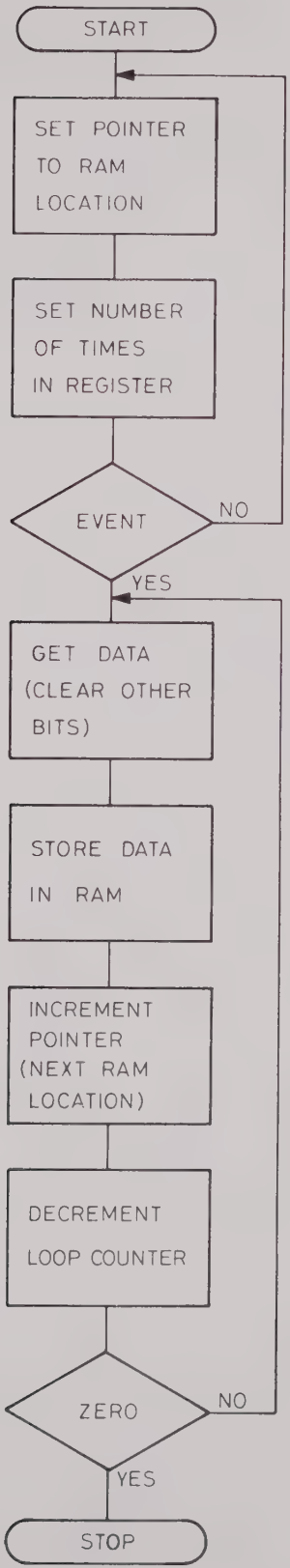


Fig. 7.4.3.2. Contact bounce routine. RD3710

Thus in this case there is adequate free space in which a program can be written.
If this were not the case, part of the parameter bank must be destroyed (overwritten). It is advisable to print out an area of RAM, towards the end of the memory so that it can be seen what it contains. This print out would then form a record of the contents which must be written back into the relevant address at the conclusion of the test.

For the purposes of this example an area of 256 addresses has been chosen, starting with the address /4700.

e.g.

```
C=TSTR4700 00FF

4700 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4710 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4720 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4730 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4740 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4750 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4760 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4770 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4780 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4790 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
47A0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
47B0 3E 05 32 20 C0 3E 06 32 20 C0 3A 20 C0 E6 04 CA
47C0 BA 47 3E 07 32 20 C0 3E 04 32 20 C0 3A 20 C0 E6
47D0 04 C2 CC 47 3E 4E 32 68 C0 3E 01 32 68 C0 3A 20
47E0 C0 E6 08 CA DE 47 3E 02 32 68 C0 C1 5D 0E C9 00
47F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

It can be seen that this printout contains the program from Chapter 7.4.2. Since the contact bounce program requires only 15 addresses it can easily be added to the existing program.

The program is shown in flow chart form in fig. 7.4.3.2. It consists of the following steps:

1. Set a pointer (microprocessor register pair H, L) to an area in the RAM where the first measured result will be stored.
2. Set the number of times the result is to be sampled (128 = /80) in microprocessor register B.
3. Read the microswitch status and store it in the first RAM location (indicated by the pointer).
4. Increment the pointer so that it indicates the next RAM location.
5. Decrement the loop counter (in microprocessor register B).
6. Repeat the cycle until the loop counter is zero.

ADDRESS	MACHINE CODE	CP(*)	LABEL	MNEMONIC	COMMENT
/47E6	21 00 47		BOUNCE	LXI H, /47/00	Pointer to buffer area
	06 80			MVI B, /80	Repeat loop 128 times
/47EB	3A 20 C0	13	LOOP1	LDA /C0/20	Get data
	77	7		MOV M, A	Store in RAM
	23	5		INX H	Increment pointer
	05	5		DCR B	Decrement loop counter
	C2 EB 47	10		JNZ LOOP1	Jump if not ready
		= 40			

(*) CP = clock periods

Fig. 7.4.3.3. Contact bounce program.

Since the microprocessor clock frequency = 2 MHz, the time for the loop (40 clock pulses) = 20 μs.

The loop counter is set to 128, thus the total time taken = 128 x 20 μs = 2.56 ms.

This program is inserted in the plunger timing program starting at address /47E6 [see fig. 4.7.2.2.]. The remaining addresses of that program are then moved up by the number of addresses in the contact bounce program (14 = /D).

The program is placed in RAM in the same way as that for the plunger timing.
The whole program can be printed out with the test command TST R 47B0 0050, resulting in the following printout:

```
47B0 3E 05 32 20 C0 3E 06 32 20 C0 3A 20 C0 E6 04 CA
47C0 BA 47 3E 07 32 20 C0 3E 04 32 20 C0 3A 20 C0 E6
47D0 04 C2 CC 47 3E 4E 32 68 C0 3E 01 32 68 C0 3A 20
47E0 C0 E6 08 CA DE 47 21 00 47 06 80 3A 20 C0 77 23
47F0 05 C2 EB 47 3E 02 32 68 C0 CD 5D 0E C9 00 00 00 (*)
(*)
```

The program can be started by typing:

TST E47B0

after which the result of the plunger timing will be printed out in the following form:

.000	0	.794
2θ angle	counts	time

The results of the contact bounce measurements will be stored in RAM addresses /4700 to /477F, and can be printed out by typing the command:

TST R 4700 0080

The results take the following form:

```
4700 5A 5A 52 52 52 52 52 52 52 52 52 52 52 52 52 5A
4710 52 52 52 52 52 52 52 52 5A 5A 5A 5A 5A 5A 52 52
4720 52 52 52 52 52 52 52 52 52 5A 5A 5A 5A 5A 5A 5A
4730 5A 5A 5A 5A 52 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A
4740 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A
4750 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A
4760 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A
4770 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 5A
```

The status of the microswitch for a period of 2.56 ms after it has first been actuated can now be seen. This is represented by the data on the memory-mapped I/O bus at address /C0 20, i.e.

/5A means MS15 actuated (PLULO– = 0)
/52 means MS15 not actuated (PLULO– = 1)

This result is shown graphically in fig. 7.4.3.4.

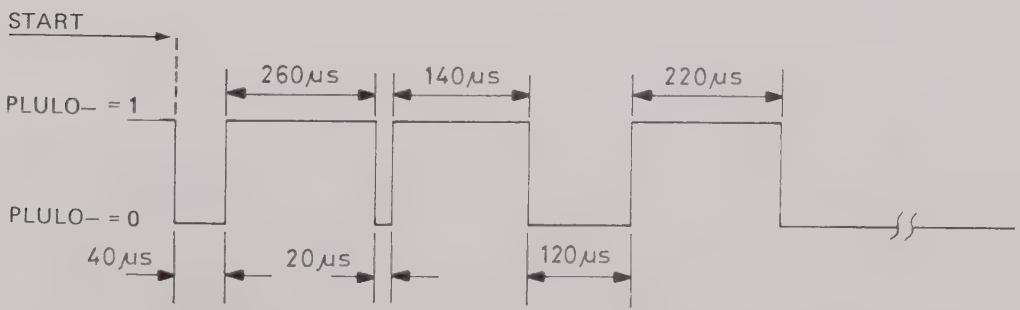


Fig. 7.4.3.4. Contact bounce derived from printout.

7.4.4. Example 3. Alphanumeric display

The alphanumeric display is multiplexed at a frequency of ≈ 500 Hz, so if a character is to be displayed continuously it must be repeatedly generated by the microprocessor. This can only be done with the aid of a program, and several methods can be used to achieve this.

The PW1400/00 software (in PROM) contains a subrroutine to enable characters to be displayed. In all software versions this subroutine causes the characters stored in the four RAM addresses /411D, /411E, /411F, and /4120 to be displayed.

To display a chosen character, first switch on the display by giving a command which causes a channel to be set, e.g. SCH CU. When the display is on it can be changed by changing the contents of the appropriate RAM address.

For example, to display the test character ✱ in all four positions, type:

TST W 411D 21 21 21 21

A complete list of the hexadecimal codes for the alphanumeric characters will be found in Chapter 7.1.12.

> **NOTE**
> This procedure does not permit the two most significant digits of the display to be tested.

A second method involves the use of a program written into RAM. A flow chart for this program is shown in fig. 7.4.4.1.

The program is composed of the following steps:

1. Load the microprocessor register pair B, C with the byte address of the most significant digit of the display (character 1).
2. Load the microprocessor accumulator with the character to be displayed.
3. Send the character to the display character byte address.
4. Switch the display on.
5. Delay subroutine to allow character to be displayed for 1 second.
6. Load the microprocessor with blank character.
7. Send blank character to display character byte address.
8. Decrement register C. If C contains 0000, jump to first step in program. If C ≠ 0000, increment register B and jump step 2. This has the result of changing the character byte address to that for the next character.

C033 08 09 9A 0B 0C 0D Address

ADDRESS	MACHINE CODE	LABEL	MNEMONIC	COMMENT
/4600	0E 06		MVI C /06	} Display byte address
	06 08		MVI B /08	
	3E 21		MVI A /21	} ASCII character
	32 32 C0		STA /C0 /32	
	78		MOV A,B	} Byte address
	32 33 C0		STA /C0/33	
	3E 01		MVI A /01	} Display on
	32 33 C0		STA /C0/33	
	CD 26 46		CALL /46 /26	Subroutine delay
	3E 20		MVI A /20	Display blank
	32 32 C0		STA /C0/32	(ASCII character)
	78		MOV A, B	} Byte address
	32 33 C0		STA /C0/33	
	0D		DCR C	} Next character
	CA 00 46		JZ /46/00	
	04		INR B	
	C3 04 46		JMP /46/04	
/4626	16 FF	DELAY	MVI D /FF	} Delay
	1E FF		MVI E /FF	
	1D		DCR E	
	C2 2A 46		JNZ /46/2A	
	15		DCR D	
	C2 28 46		JNZ /46/28	
	C9		RET	

Fig. 7.4.4.2. Display test program.

The delay subroutine involves filling two registers with /FF and decrementing them until both contain /00.

The whole program can be printed out with the test command TST R 4600 0040, resulting in the following printout:

```
4600 0E 06 06 08 3E 21 32 32 C0 78 32 33 C0 3E 01 32
4610 33 C0 CD 26 46 3E 20 32 32 C0 78 32 33 C0 0D CA
4620 00 46 04 C3 04 46 16 FF 1E FF 1D C2 2A 46 15 C2
4630 28 46 C9 00 00 00 00 00 00 00 00 00 00 00 00 00
```

A third method, enabling single characters to be displayed in each character position separately is given in chapter 7.1.12.

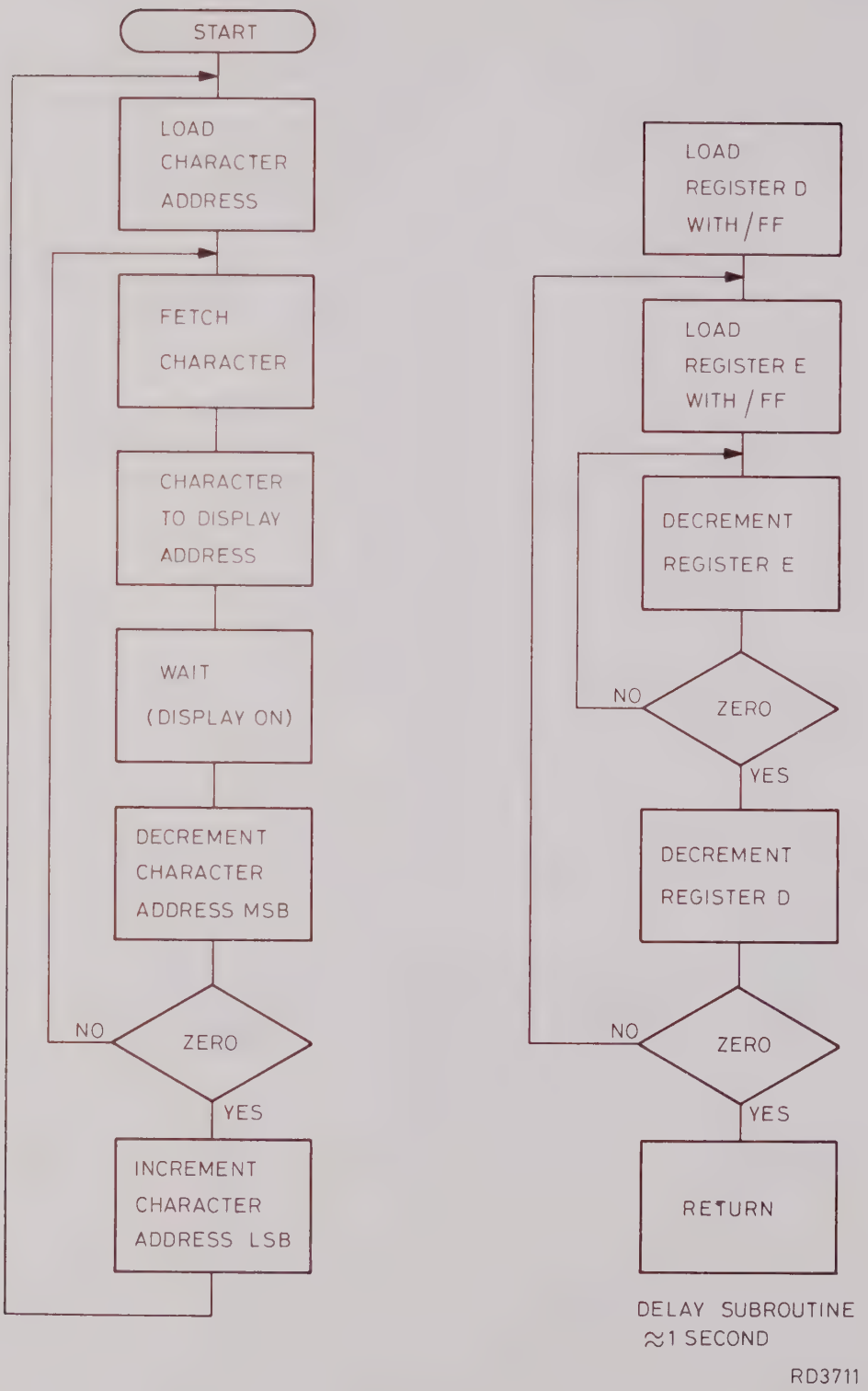


Fig. 7.4.4.1. Display test flow chart.

7.4.5. Microprocessor 8080A instruction set

This Chapter includes a listing of the 8080A instruction set in hexadecimal format in two forms:

1. In functional groups
2. In hexadecimal sequence

They are included in this manual as a handy survey for those who have followed an appropriate course or who have experience in programming microprocessors. For those without suitable experience and without a thorough knowledge of the mechanical requirements of the PW 1400/00, it is recommended that they do not attempt to write test programs for themselves.

Further information on the instruction set, on the 8080A microprocessor and on programming can be found in the following books:

INTEL	8080 Microcomputer Systems users manual. Available from: Intel corporation, 3065 Bowers Avenue, Santa Clara, California 95051 USA or from local Intel sales and marketing offices
PHILIPS	Signetics integrated circuits – bipolar and M.O.S. microprocessors. Available from: Signetics Corporation, 811 East Arques Avenue, Sunnyvale, California 94086 USA or from local Philips sales and marketing offices.
NEC	NEC Catalog Available from: NEC Electronics (Europe) G.m.b.H. Karlstrasse 123-127, 4000 Düsseldorf 1, West Germany
AMD	The 8080A/9080A M.O.S. Microprocessor Handbook Available from: Advanced Micro Devices Inc., 915 De Gsigne Drive, Sunnyvale, California, 94086 USA or from local AMD Sales offices and representatives.

8080 INSTRUCTION SET

In functional groups

JUMP

C3	JMP	Adr
C2	JNZ	
CA	JZ	
D2	JNC	
DA	JC	
E2	JPO	
EA	JPE	
F2	JP	
FA	JM	
E9	PCHL	

CALL

CD	CALL	Adr
C4	CNZ	
CC	CZ	
D4	CNC	
DC	CC	
E4	CPO	
EC	CPE	
F4	CP	
FC	CM	

RETURN

C9	RET
C0	RNZ
C8	RZ
D0	RNC
D8	RC
E0	RPO
E8	RPE
F0	RP
F8	RM

RESTART

C7	RST	0
CF	RST	1
D7	RST	2
DF	RST	3
E7	RST	4
EF	RST	5
F7	RST	6
FF	RST	7

MOVE IMMEDIATE

06	MVI	B, D8
0E	MVI	C,
16	MVI	D,
1E	MVI	E,
26	MVI	H,
2E	MVI	L,
36	MVI	M,
3E	MVI	A,

Acc IMMEDIATE*

C6	ADI	D8
CE	ACI	
D6	SUI	
DE	SBI	
E6	ANI	
EE	XRI	
F6	ORI	
FE	CPI	

LOAD IMMEDIATE

01	LXI	B, D16
11	LXI	D,
21	LXI	H,
31	LXI	SP,

STACK OPS

C5	PUSH	B
D5	PUSH	D
E5	PUSH	H
F5	PUSH	PSW
C1	POP	B
D1	POP	D
E1	POP	H
F1	POP	PSW*
E3	XTHL	
F9	SPHL	

DOUBLE ADD+

09	DAD	B
19	DAD	D
29	DAD	H
39	DAD	SP

INCREMENT**

04	INR	B
0C	INR	C
14	INR	D
1C	INR	E
24	INR	H
2C	INR	L
34	INR	M
3C	INR	A
03	INX	B
13	INX	D
23	INX	H
33	INX	SP

DECREMENT**

05	DCR	B
0D	DCR	C
15	DCR	D
1D	DCR	E
25	DCR	H
2D	DCR	L
35	DCR	M
3D	DCR	A
0B	DCX	B
1B	DCX	D
2B	DCX	H
3B	DCX	SP

LOAD/STORE

0A	LDAX	B
1A	LDAX	D
2A	LHLD	Adr
3A	LDA	Adr
02	STAX	B
12	STAX	D
22	SHLD	Adr
32	STA	Adr

SPECIALS

EB	XCHG
27	DAA*
2F	CMA
37	STC+
3F	CMC+

INPUT/OUTPUT

D3	OUT	D8
DB	IN	

CONTROL

00	NOP
76	HLT
F3	DI
FB	EI

ROTATE+

07	RLC
0F	RRC
17	RAL
1F	RAR

D8 = constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.

* = all Flags (C, Z, S, P, AC) affected

\+ = only CARRY affected

Adr = 16 bit address

** = all flags except CARRY affected; (exception: INX & DCX affect no Flags)

MOVE

40	MOV	B, B
41	MOV	B, C
42	MOV	B, D
43	MOV	B, E
44	MOV	B, H
45	MOV	B, L
46	MOV	B, M
47	MOV	B, A
48	MOV	C, B
49	MOV	C, C
4A	MOV	C, D
4B	MOV	C, E
4C	MOV	C, H
4D	MOV	C, L
4E	MOV	C, M
4F	MOV	C, A
50	MOV	D, B
51	MOV	D, C
52	MOV	D, D
53	MOV	D, E
54	MOV	D, H
55	MOV	D, L
56	MOV	D, M
57	MOV	D, A
58	MOV	E, B
59	MOV	E, C
5A	MOV	E, D
5B	MOV	E, E
5C	MOV	E, H
5D	MOV	E, L
5E	MOV	E, M
5F	MOV	E, A
60	MOV	H, B
61	MOV	H, C
62	MOV	H, D
63	MOV	H, E
64	MOV	H, H
65	MOV	H, L
66	MOV	H, M
67	MOV	H, A
68	MOV	L, B
69	MOV	L, C
6A	MOV	L, D
6B	MOV	L, E
6C	MOV	L, H
6D	MOV	L, L
6E	MOV	L, M
6F	MOV	L, A
70	MOV	M, B
71	MOV	M, C
72	MOV	M, D
73	MOV	M, E
74	MOV	M, H
75	MOV	M, L
	-----	-----
77	MOV	M, A

ACCUMULATOR*

80	ADD	B
81	ADD	C
82	ADD	D
83	ADD	E
84	ADD	H
85	ADD	L
86	ADD	M
87	ADD	A
88	ADC	B
89	ADC	C
8A	ADC	D
8B	ADC	E
8C	ADC	H
8D	ADC	L
8E	ADC	M
8F	ADC	A
90	SUB	B
91	SUB	C
92	SUB	D
93	SUB	E
94	SUB	H
95	SUB	L
96	SUB	M
97	SUB	A
98	SBB	B
99	SBB	C
9A	SBB	D
9B	SBB	E
9C	SBB	H
9D	SBB	L
9E	SBB	M
9F	SBB	A
A0	ANA	B
A1	ANA	C
A2	ANA	D
A3	ANA	E
A4	ANA	H
A5	ANA	L
A6	ANA	M
A7	ANA	A
A8	XRA	B
A9	XRA	C
AA	XRA	D
AB	XRA	E
AC	XRA	H
AD	XRA	L
AE	XRA	M
AF	XRA	A
B0	ORA	B
B1	ORA	C
B2	ORA	D
B3	ORA	E
B4	ORA	H
B5	ORA	L
B6	ORA	M
B7	ORA	A

PSEUDO INSTRUCTION

ORG	Adr	
END		
EQU	D16	
SET	D16	
DS	D16	
DB	D8	[ ]
DW	D16	[ ]
IF	D16	
ENDIF		
MACRO		[ ]
ENDM		

CONSTANT DEFINITION

0BDH 1 AH	Hex
105D 105	Decimal
72O 72Q	Octal
11011B 00110B	Binary
"TEST" "A" "B"	ASCII

OPERATORS

(,)
* , / , MOD, SHL, SHR
+ , –
NOT
AND
OR, XOR

STANDARD SETS

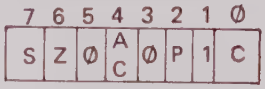
A	SET	7
B	SET	0
C	SET	1
D	SET	2
E	SET	3
H	SET	4
L	SET	5
M	SET	6
SP	SET	6
PSW	SET	6

MOVE **ACCUMULATOR***

(continued)

78	MOV	A, B	B8	CMP	B
79	MOV	A, C	B9	CMP	C
7A	MOV	A, D	BA	CMP	D
7B	MOV	A, E	BB	CMP	E
7C	MOV	A, H	BC	CMP	H
7D	MOV	A, L	BD	CMP	L
7E	MOV	A, M	BE	CMP	M
7F	MOV	A, A	BF	CMP	A

FLAG BYTE STACK FORMAT



In numerical order

00	NOP		31	LXI	SP, D16	62	MOV	H, D	93	SUB	E
01	LXI	B, D16	32	STA	Adr	63	MOV	H, E	94	SUB	H
02	STAX	B	33	INX	SP	64	MOV	H, H	95	SUB	L
03	INX	B	34	INR	M	65	MOV	H, L	96	SUB	M
04	INR	B	35	DCR	M	66	MOV	H, M	97	SUB	A
05	DCR	B	36	MVI	M, D8	67	MOV	H, A	98	SBB	B
06	MVI	B, D8	37	STC		68	MOV	L, B	99	SBB	C
07	RLC		38	- - -		69	MOV	L, C	9A	SBB	D
08	- - -		39	DAD	SP	6A	MOV	L, D	9B	SBB	E
09	DAD	B	3A	LDA	Adr	6B	MOV	L, E	9C	SBB	H
0A	LDAX	B	3B	DCX	SP	6C	MOV	L, H	9D	SBB	L
0B	DCX	B	3C	INR	A	6D	MOV	L, L	9E	SBB	M
0C	INR	C	3D	DCR	A	6E	MOV	L, M	9F	SBB	A
0D	DCR	C	3F	MVI	A, D8	6F	MOV	L, A	A0	ANA	B
0E	MVI	C, D8	3F	CMC		70	MOV	M, B	A1	ANA	C
0F	RRC		40	MOV	B, B	71	MOV	M, C	A2	ANA	D
10	- - -		41	MOV	B, C	72	MOV	M, D	A3	ANA	E
11	LXI	D, D16	42	MOV	B, D	73	MOV	M, E	A4	ANA	H
12	STAX	D	43	MOV	B, E	74	MOV	M, H	A5	ANA	L
13	INX	D	44	MOV	B, H	75	MOV	M, L	A6	ANA	M
14	INR	D	45	MOV	B, L	76	HLT		A7	ANA	A
15	DCR	D	46	MOV	B, M	77	MOV	M, A	A8	XRA	B
16	MVI	D, D8	47	MOV	B, A	78	MOV	A, B	A9	XRA	C
17	RAL		48	MOV	C, B	79	MOV	A, C	AA	XRA	D
18	- - -		49	MOV	C, C	7A	MOV	A, D	AB	XRA	E
19	DAD	D	4A	MOV	C, D	7B	MOV	A, E	AC	XRA	H
1A	LDAX	D	4B	MOV	C, E	7C	MOV	A, H	AD	XRA	L
1B	DCX	D	4C	MOV	C, H	7D	MOV	A, L	AE	XRA	M
1C	INR	E	4D	MOV	C, L	7E	MOV	A, M	AF	XRA	A
1D	DCR	E	4E	MOV	C, M	7F	MOV	A, A	B0	ORA	B
1E	MVI	E, D8	4F	MOV	C, A	80	ADD	B	B1	ORA	C
1F	RAR		50	MOV	D, B	81	ADD	C	B2	ORA	D
20	- - -		51	MOV	D, C	82	ADD	D	B3	ORA	E
21	LXI	H, D16	52	MOV	D, D	83	ADD	E	B4	ORA	H
22	SHLD	Adr	53	MOV	D, E	84	ADD	H	B5	ORA	L
23	INX	H	54	MOV	D, H	85	ADD	L	B6	ORA	M
24	INR	H	55	MOV	D, L	86	ADD	M	B7	ORA	A
25	DCR	H	56	MOV	D, M	87	ADD	A	B8	CMP	B
26	MVI	H, D8	57	MOV	D, A	88	ADC	B	B9	CMP	C
27	DAA		58	MOV	E, B	89	ADC	C	BA	CMP	D
28	- - -		59	MOV	E, C	8A	ADC	D	BB	CMP	E
29	DAD	H	5A	MOV	E, D	8B	ADC	E	BC	CMP	H
2A	LHLD	Adr	5B	MOV	E, E	8C	ADC	H	BD	CMP	L
2B	DCX	H	5C	MOV	E, H	8D	ADC	L	BE	CMP	M
2C	INR	L	5D	MOV	E, L	8E	ADC	M	BF	CMP	A
2D	CDR	L	5E	MOV	E, M	8F	ADC	A	C0	RNZ	
2E	MVI	L, D8	5F	MOV	E, A	90	SUB	B	C1	POP	B
2F	CMA		60	MOV	H, B	91	SUB	C	C2	JNZ	Adr
30	- - -		61	MOV	H, C	92	SUB	D	C3	JMP	Adr

D8 = constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.

Adr = 16 bit addres

In numerical order

(continue)

C4	CNZ	Adr	F2	JP	Adr
C5	PUSH	B	F3	DI	
C6	ADI	D8	F4	CP	Adr
C7	RST	0	F5	PUSH	PSW
C8	RZ		F6	ORI	D8
C9	RET		F7	RST	6
CA	JZ	Adr	F8	RM	
CB	- - -		F9	SPHL	
CC	CZ	Adr	FA	JM	Adr
CD	CALL	Adr	FB	EI	
CE	ACI	D8	FC	CM	Adr
CF	RST	1	FD	— —	
D0	RNC		FE	CPI	D8
D1	POP	D	FF	RST	7
D2	JNC	Adr			
D3	OUT	D8			
D4	CNC	Adr			
D5	PUSH	D			
D6	SUI	D8			
D7	RST	2			
D8	RC				
D9	- - -				
DA	JC	Adr			
DB	IN	D8			
DC	CC	Adr			
DD	- - -				
DE	SBI	D8			
DF	RST	3			
E0	RPO				
E1	POP	H			
E2	JPO	Adr			
E3	XTHL				
E4	CPO	Adr			
E5	PUSH	H			
E6	ANI	D8			
E7	RST	4			
E8	RPE				
E9	PCHL				
EA	JPE	Adr			
EB	XCHG				
EC	CPE	Adr			
ED	- - -				
EE	XRI	D8			
EF	RST	5			
F0	RP				
F1	POP	PSW			

D8 = constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.

Adr = 16 bit address

Hexadecimal-ASCII table

00	NUL		2B	+	56	V	
01	SOH		2C	,	57	W	
02	STX		2D	–	58	X	
03	ETX		2E	.	59	Y	
04	EOT		2F	/	5A	Z	
05	ENQ		30	0	5B	[	
06	ACK		31	1	5C	\	(↑)
07	BEL		32	2	5D	]	(←)
08	BS		33	3	5E	'	
09	HT		34	4	5F	_	
0A	LF		35	5	60	@	
0B	VT		36	6	61	a	
0C	FF		37	7	62	b	
0D	CR		38	8	63	c	
0E	SO		39	9	64	d	
0F	SI		3A	:	65	e	
10	DLE		3B	;	66	f	
11	DC1	(X-ON)	3C	<	67	g	
12	DC2	(TAPE)	3D	=	68	h	
13	DC3	(X-OFF)	3E	>	69	i	
14	DC4		3F	?	6A	j	
15	NAK		40	α	6B	k	
16	SYN		41	A	6C	l	
17	ETB		42	B	6D	m	
18	CAN		43	C	6E	n	
19	EM		44	D	6F	o	
1A	SUB		45	E	70	p	
1B	ESC		46	F	71	q	
1C	FS		47	G	72	r	
1D	GS		48	H	73	s	
1E	RS		49	I	74	t	
1F	US		4A	J	75	u	
20	SP		4B	K	76	v	
21	!		4C	L	77	w	
22	"		4D	M	78	x	
23	#		4E	N	79	y	
24	$		4F	O	7A	z	
25	%		50	P	7B	{	
26	&		51	Q	7C	|	
27	'		52	R	7D	}	(ALT MODE)
28	(		53	S	7E	~	
29	)		54	T	7F	DEL	(RUB OUT)
2A	*		55	U			

7.5. ACCEPTANCE TEST

The following test procedure will give some measure of assurance that the PW 1400/00 is in good working order. It consists of a stability test and an overall reproducibility test in which all parameters are varied. If this test is failed in any respect, further tests of individual parameters must be made to isolate the fault. A series of tests of individual parameters is included.

At least seven hours before the test is started the spectrometer cabinet must be closed, the temperature stabilization working correctly, and the X-ray tube power set to 2kW (50kV, 40mA).
This ensures proper stabilization of the spectrometer. At the end of this stabilization period the goniometer angles of all the channels to be used in the test procedure must be calibrated using the software command CAN xxi. The calibration procedures can be assembled for all channels in a job if desired.
It is the intention that this test be carried out at the end of each service visit and that the results should form the basis of an agreement between the service organization and the client that the equipment is being left in good working order.

7.5.1. Initial test conditions

Before the test is started the following channels, measuring programs, and jobs should be assembled. The identifications used for these in this description are arbitrary, and in practice may already have been used so that other channel names must be chosen. If insufficient space remains in the parameter bank, this should be dumped for subsequent reading back into the memory.

It is also assumed that:

Crystal 1= Lif 200
Crystal 2= PE
Mask 1 = no mask fitted
Mask 2 = 24mm mask

Auxiliary collimator = fitted
Sample turret pos. 1 = Copper
Sample turret pos. 2 = Aluminium
Sample turret pos. 3 = Stainless steel
Vacuum = On

} Test samples delivered with the spectrometer.

If these conditions cannot achieved in the spectrometer being tested, the local conditions must be taken into account.
Assemble the following test channels:

Cu Chan. TA	KA	NO	F	S	1	1	90	20	50	50	45.030	.00	.00
Ni Chan. TB	KA	NO	F	FS	1	1	80	15	50	50	48.680	.00	.00
Fe Chan. TC	KA	NO	F	F	1	1	80	15	50	50	57.490	.00	.00
Cr Chan. TD	KA	YE	F	F	1	1	80	12	50	50	69.360	.00	.00
Al Chan. TE	KA	NO	C	F	2	1	90	20	50	50	145.130	.00	.00

Assemble the following measuring programs:

```
MP 60

MASK :  1
ABS  : YE

CHAN   PT   PC
TA    100  0E0
```

```
MP 61

MASK :  1
ABS  : YE

CHAN   PT   PC
TB    400  0E0
TC    100  0E0
TD    400  0E0
```

```
MP 62

MASK :  1
ABS  : YE

CHAN   PT   PC
TE    100  0E0
```

Assemble the following job:

```
* AJB 60
J = RMS0
J = SMX60
SAM.POS. = 1
J = SMX62
SAM.POS. = 2
J = SMX61
SAM.POS. = 3
J = EJB
```

The test should be started with:

1. RCJ0 (Recycle job continuously)
2. RCM1 (Perform measuring program once)
3. SJB60 (Start job 60)

For adequate results to be obtained, the test must continue for a minimum of 15 hours (1 night) and a maximum of 24 hours.

7.5.2. Test results

From the test results, calculate the mean value (Im), and find the maximum (I max.) and minimum (I min.) values for each element Calculate for each element.

$$\frac{I\,max - I\,min}{Im} \times 100\%.$$

The calculated values must then be better than the following values.

Element	$\frac{I\,max - I\,min}{Im} \times 100\%$
Cr (TD)	$< 0{,}46$
Ni (TB)	$< 0{,}46$
Fe (TC)	$< 0{,}46$
Al (TE)	$< 0{,}46$
Cu (TA)	$< 0{,}66$

If other elements, crystals, or masks are used then other values may apply.
If any part of this test is failed, the particular parameter giving rise to the fault must be isolated.
This can be done by using the tests given in 7.5.3. to 7.5.11.

NOTE

With a countrate of 5.10^5 cps the number of counts collected in 200 seconds will be 10^8. The maximum number of characters that can be printed is 8. Thus in practice the most significant digit (1 in this case) will not be included in the printout but must be taken into account in the calculation of stability.
Also the leading zeros will be suppressed i.e., 100635451 will be printed as 635451.

7.5.3. Parameter tests

The initial test conditions given in Chapter 7.5.1. apply for these tests also unless otherwise stated. The spectrometer must be fully stabilized as stated in Chapter 7.5. In addition, several extra channels, measuring programs and jobs should be assembled.

Assemble the following channles:

```
Cu Chan. TF   KA  NO  F   F   1   1   80  20  50  40  45.030   .00   .00
Cu Chan. TG   KA  NO  C   S   1   2   80  20  50  60  99.900   .00   .00
Cu Chan. TH   KA  NO  F   F   1   1   80  20  40  30  45.030   .00   .00
```

Assemble the following measuring program:

```
MP 63

MASK :  1
ABS  : YE

CHAN   PT   PC
TH    200  0E0
```

Assemble the following jobs:

```
AJB  48
PTC  100  0
SMP  1
SCT
SMP  3
EJB

AJB  50
PTC  100  0
SMP  3
SCT
SMP  1
EJB

AJB  52
PTC  100  0
MSK  1
SCT
MSK  2
EJB

AJB  54
PTC  400
COL  F
SCT
COL  C
EJB
```

```
AJB  49
PTC  100  0
SMP  2
SCT
SMP  4
EJB

AJB  51
PTC  100  0
SMP  4
SCT
SMP  2
EJB

AJB  53
PTC  100  0
MSK  2
SCT
MSK  1
EJB

AJB  55
PTC  400
COL  C
SCT
COL  F
EJB
```

```
AJB  56
PTC  400
XTL  1
SCT
XTL  3
XTL  2
XTL  4
XTL  6
XTL  5
EJB
```

```
AJB  58
PTC  400
SCH  TG
SCT
SLF  130
SLF  90
EJB.
```

```
AJB  57
PTC  400
SCH  TF
SCT
SLF  42
EJB
```

7.5.4. Static stability

During this test of static stability, repeated measurements of counts and time are made on one copper sample, but no parameters are changed.

Ensure that the copper sample is in position 1 of the sample turret.
Set the following parameters:

SCH TH (Copper channel)

MSK 1 (Mask 1)

SPN N (Spinner off)

Check that the copper channel settings give a maximum intensity of approximately 5.10^5 cps. If necessary modify the kV and mA in channel TH to achieve this.

Start the measuring program by giving the following commands:

RCM 0	(recycle the measuring program continuously)
SMX 63	(start measuring program 63)
SAMPLES 1	(measure sample in position 1 only)

Continue the measurements for 24 hours. The overall variation (peak-to-peak) in the measured values must be less than 0,25% of the mean of the measured values.

> **NOTE**
>
> With a countrate of 5.10^5 cps the number of counts collected in 200 seconds will be 10^8. The maximum number of characters that can be printed is 8. Thus in practice the most significant digit (1 in this case) will not be included in the printout but must be taken into account in the calculation of stability.
> Also the leading zeros will be suppressed i.e., 100635451 will be printed as 635451.

7.5.5. Reproducibility of sample turret

In this test of sample turret reproducibility the same sample in the same sample holder is placed in each of the sample turret positions in turn, and 20 measurements are made.

Set the following parameters:

1. SCH TH (Copper Channel)
2. MSK 1 (Mask 1)
3. SPN Y (Spinner on)

Check that the channel settings give a maximum intensity of approximately 5.10^5 cps. If necessary modify the kV and mA in channel TH to achieve this.

4. SLP 1 (Sample to loading position 1)
5. Load sample in position 1
6. RCJ 20 (Recycle job 20 times)
7. SJB 48 (Start job 48)

When the 20 measurements have been made in turret position 1, remove the sample and continue with:

8. SLP 2 (Sample to loading position 2)
9. Load sample in position 2
10. RCJ 20 (Recycle job 20 times)
11. SJB 49 (Start job 49)

When the 20 measurements have been made in turret position 2, remove the sample and continue with:

12. SLP 3 (Sample to loading position 3)
13. Load sample in position 3
14. RCJ 20 (Recycle job 20 times)
15. SJB 50 (Start job 50)

When the 20 measurements have been made in turret position 3, remove the sample and continue with:

16. SLP 4 (Sample to loading position 4)
17. Load sample in position 4
18. RCJ 20 (Recycle job 20 times)
19. SJB 51 (Start job 51)

Find the highest (I_H) and the lowest (I_L) values, and calculate the mean value (I_{M1}) of all the measurements made in each position of the sample turret.

$$\frac{I_H - I_L}{I_{M1}} \times 100 < 0,3\ \%$$

Calculate the mean value of all the measurements made in all positions of the sample turret taken together. If this is I_{M2} and the highest and lowest of the mean values found for the four turret positions are I_{MH} and I_{ML} respectively, then:

$$\frac{I_{MH} - I_{ML}}{I_{M2}} \times 100 < 0,3\ \%$$

7.5.6. Reproducibility of the mask

In this test the reproducibility of each mask is measured separately. This is necessary because the masks are normally of different sizes. The test is continued until 20 measurements have been made.

Set the following parameters:

SCH TH (Copper Channel)
MSK 1 (Mask1)

Check that the copper channel settings give an intensity of approximately 5.10^5cps. If necessary modify channel TH (kV and mA) to achieve this.

7.5.6.1. Mask no 1

Start the measuring program by giving the following commands:

RCJ 20 (recycle job 20 times)
SJB 52 (start job 52)

Find the highest (I_H) and the lowest (I_L) values and calculate the mean value (I_M) of all the measurements made,then:

$$\frac{I_H - I_L}{I_M} \times 100 < 0,2\ \%$$

7.5.6.2. Mask no 2.

Set the following parameters:

SCH TH (Copper Channel)
MSK 2 (Mask 2)

Check that the copper channel settings give an intensity of approximately 5.10^5 cps. If necessary, modify channel TH (kV & mA) to achieve this.

Start the measuring program by giving the following commands:

RCJ 20 (recycle job 20 times)
SJB 53 (start job 53)

Find the highest (I_H) and the lowest (I_L) values and calculate the mean value (I_M) of all the measurements made, then:

$$\frac{I_H - I_L}{I_M} \times 100 < 0{,}2\ \%$$

7.5.7. Determination of slope at 50% peak intensity

Before any of the following tests are performed, calculate the slope of the copper peak as follows:

Set the following parameters:

1. SCH TF (Set channel TF)
2. CAN TF (Calibrate channel TF)
3. Record the countrate at the peak angle I_{max}
4. Determine the angle on the foreflank of the peak at which the countrate is 50% of I_{max} ($= I_S$)
5. Determine the kV and mA settings to give $\approx 5.10^5$ cps at I_S
6. Modify channel TF to include the new angle and kV and mA settings
7. Make a measurement (10 seconds) at an angle of $0.01^o\ 2\theta$ on either side of the angle giving I_S (I_{S+1} and I_{S-1}) and express these in counts per second.
   Calculate the slope of the peak as follows (see fig. 7.5.7.)

$$\frac{\Delta I_S}{\Delta\ 2\theta_S} = \frac{I_{S+1} - I_{S-1}}{2} \text{ counts } s^{-1}/0.01^o 2\theta$$

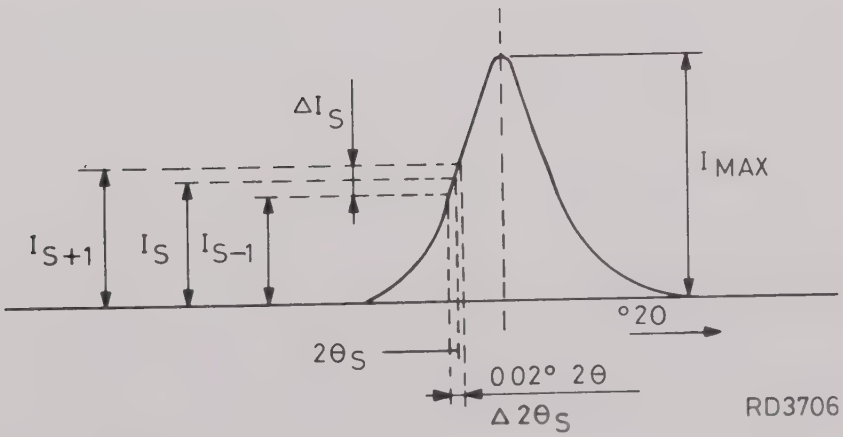


Fig. 7.5.7. Determination of peak slope

7.5.8. Reproducibility of the collimator

7.5.8.1. Fine collimator

Set the following parameters:

SCH TF (Copper channel giving I_S)
RCJ 20 (Recycle job 20 times)
SJB 54 (Start job 54)

From the 20 measurements and the slope found in 7.5.7., determine the highest (I_H) and the lowest (I_L) and calculate the reproducibility:

$$\frac{I_H - I_L}{\frac{\triangle I_S}{\triangle 2\theta_S} \times 40}$$

This must be less than $5.10^{-3\ o}2\theta$

7.5.8.2. Coarse Collimator

Set the following parameters:

SCH TF (Copper channel giving I_S)
RCJ 20 (Recycle job 20 times)
SJB 55 (Start job 55)

From the 20 measurements and the slope found in 7.5.7., determine the highest (I_H) and the lowest (I_L) and calculate the reproducibility:

$$\frac{I_H - I_L}{\frac{\triangle I_S}{\triangle 2\theta_S} \times 40}$$

This must be less than $5.10^{-3o}2\theta$

7.5.9. Reproducibility of the crystal changer

Set the following parameters:

SCH TF (Copper Channel giving I_S)
RCJ 20 (Recycle job 20 times)
SJB 56 (Start job 56)

From the 20 measurements obtained for the LiF 200 crystal and the slope found in 7.5.7., determine the highest (I_H) and lowest (I_L) and calculate the reproducibility:

$$\frac{I_H - I_L}{\frac{\triangle I_S}{\triangle 2\theta_S} \times 40}$$

This must be less than $3.10^{-3}\ ^{o}2\theta$

7.5.10. Reproducibility of 2θ angle

Set the following parameters:

SCH TF (Copper Channel giving I_S)
RCJ 20 (Recycle job 20 times)
SJB 57 (Start job 57)

From the 20 measurements and the slope found in 7.5.7. determine the highest (I_H) and the lowest (I_L) and calculate the reproducibility:

$$\frac{I_H - I_L}{\frac{\triangle I_S}{\triangle 2\theta_S} \times 40}$$

This must be less than $3.10^{-3}\ ^{o}2\theta$

7.5.11. Reproducibility of the scintillation detector arm

This test checks the reproducibility of the scintillation detector arm after uncoupling and re-coupling.
Set the following parameters:

SCH TG (2 nd order Copper Channel giving I_S)

Calibrate channel TG and calculate the slope of the fore-flank of the 2nd order copper peak in the same way as given in 7.5.7. Set the kV and mA to give $\approx 5.10^5$ cps at the angle giving I_S)
(This countrate may not be possible if the auxiliary collimator is fitted)

SCH TG (2 nd order Copper Channel giving I_S)

RCJ 20 (Recycle job 20 times)

SJB 58 (Start job 58)

From the 20 measurements and the slope of the peak, determine the highest (I_H) and the lowest (I_L) and calculate the reproducibility:

$$\frac{I_H - I_L}{\frac{\triangle I_S}{\triangle 2\theta_S} \times 40}$$

This must be less than $3.10^{-3}\ ^o2\theta$

7.6. SAMPLE LOADER PW1500/00/05/06 AND SAMPLE CHANGER PW1500/10/15/16

This paragraph describes the functional testing, mechanical and electrical adjustment, and the periodic maintenance of the sample loader and changer.

7.6.1. Functional tests

The loader or changer operation can be checked before being fixed to the spectrometer (provided the cable connections are made), or after the final installation. The testing of individual functions is made by typing test commands, or complete operations by giving the software commands described in the Operation Manual.

7.6.1.1. *Test commands*

Switch on.
The sample changer can be switched on (lamp E1 lights) when the following test command is typed:
C = TSTWC08701.

Tray movement (see fig. 7.6.1.1.)

The various functions of the sample changer can be checked, as follows:

C = TSTWC08780 – the sample changer (loader) is switched off, and lamp E1 is extinguished.
C = TSTWC08701 – sample changer is switched again.
Place a sample tray on the changer platform.
C = TSTWC08F80 – the queueing motor runs to bring the tray towards the loading rest position, micro-switches S11 and S15 will operate to inhibit tray movement.
C = TSTCW08F80 – the C after TST causes a continuous operation. Give a slash (/) to break the operation, and return to C = dialog. Tray in loading position.
C = TSTWC08F10 – the tray (at spectrometer side) will be moved one position to the right.
C = TSTCW08F10 – as above but tray shift continues.
C = TSTWC08F08 – the tray will now be moved one position to the left.
C = TSTCW08F08 – as above, but tray shift continues.
C = TSTWC08F80 – the tray moves to the front until S12 and S16 are actuated.
C = TSTWC08F40 – the tray will move to the left until S14 is actuated.
C = TSTWC08F80 – queueing motor runs, and tray moves to the loading rest position.
C = TSTWC08F10 – tray moves one position to the right, and the sample holder in position one is ready to be loaded to the spectrometer.

Grab arm operation

C = TSTWC08720 – the grab arm moves from the rest position to engage the sample in the tray (step 1 of figure 7.6.1.2.).
C = TSTWC08702 – step 2, vertical movement up.
C = TSTWC08720 – step 3, horizontal movement to spectrometer.
C = TSTWC08702 – step 4, vertical movement down.
C = TSTWC08720 – step 5, the grab arm returns to the rest position.

Use these commands to adjust the grab arm assembly so that the pick-up and loading of the sample holder is correct – see paragraph 3.21.4.1.

The unload cycle of the grab arm is performed as follows (see fig. 7.6.1.2.):

C = TSTWC08704 – step 6, grab arm to the spectrometer.
C = TSTWC08702 – step 7, vertical movement up.
C = TSTWC08704 – step 8, horizontal movement to the changer.
C = TSTWC08702 – step 9, vertical movement down.
C = TSTWC08704 – step 10, grab arm to the rest position.

Optical reader

To check the optical reader it is suggested that the identification cards shown in figure 7.6.1.3. be prepared, and inserted in sample trays as required.

To check that the reader is performing correctly, first position a tray (with identification card inserted) in front of the optical reader – in the loading rest position.

Give the command C = TSTRC083 and the read out will show "C083 xx", where xx is the tray number from the card. If a VDU is used as the main terminal the command TSTCRC083 can be given to obtain a continuous read out.

In a similar manner the program number can be checked by giving the command TSTRC08B, and the read out will show "C08B xx", when xx is the card program number.

If an incorrect read-out is given the positions of the relevant light emitter and /or receiver should be adjusted until correct.

7.6.2. Hardware status

At switch on, when the spectrometer RESET (bus interface card) push-button is operated, or when TST U is used, the microprocessor program is initiated and a read out of the hardware status is output, e.g.:

```
**
** PW1400 TEST PROCEDURE
** PROMS (UV 2.0)CARD 1 TESTED
** PROMS (UV 2.0)CARD 2 TESTED
** RAMS TESTED
** HW STATUS: 52 15 00 DB 7F FF 83 82 82 82 82 82
**    .000          0      .000
C=
```

The underlined part shows the status of the sample changer, and in this case a sample changer (and card A11) is not present.

The hardware status for the sample changer should be interpreted as follows:

** HW STATUS: 53 16 00 E6 00 BE FF 83 00 00 00 00 00	Card A11 is present but changer is not connected.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 C0	Changer connected, no trays present, motors and grab arm at rest.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 D0	Switch S15 activated.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 C1	Switch S11 activated.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 C4	Switch S13 activated.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 C2	Switch S12 activated.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 E0	Switch S16 activated.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 40	Switch S18 activated, tray at rest in front position.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 B2 00 00 80	Switch S17 activated, tray at rest at spectrometer side.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 A2 00 00 C0	Grab arm not at rest.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 A3 00 00 C0	Grab arm at end of step 1, tray pick-up.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 A9 00 00 C0	Grab arm at end of step 2, vertical over tray.
** HW STATUS: 53 16 00 EA 00 BE FF 83 00 AC 00 00 C0	Grab arm at end of step 3, vertical over spectrometer hole.

A complete summary of hardware status and test commands will be found in paragraph 7.1.13.

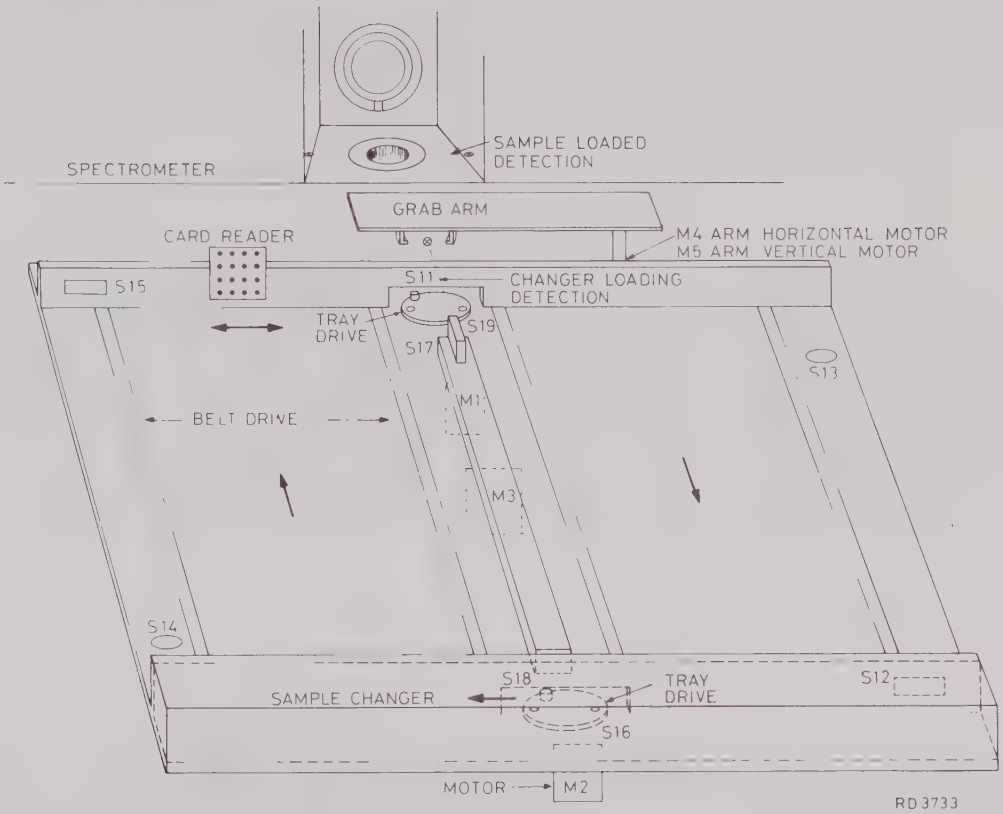


Fig. 7.6.1.1. Sample changer lay out

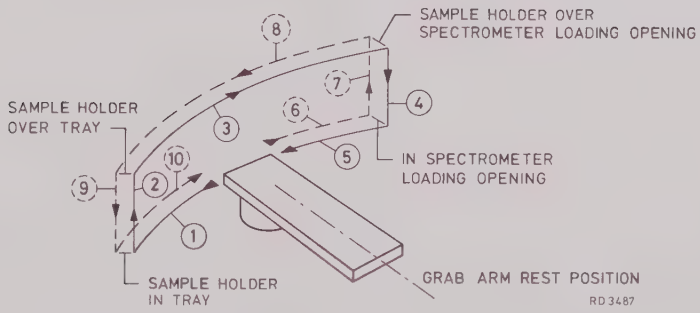

SAMPLE HOLDER OVER SPECTROMETER LOADING OPENING
SAMPLE HOLDER OVER TRAY
IN SPECTROMETER LOADING OPENING
SAMPLE HOLDER IN TRAY
GRAB ARM REST POSITION
RD 3487

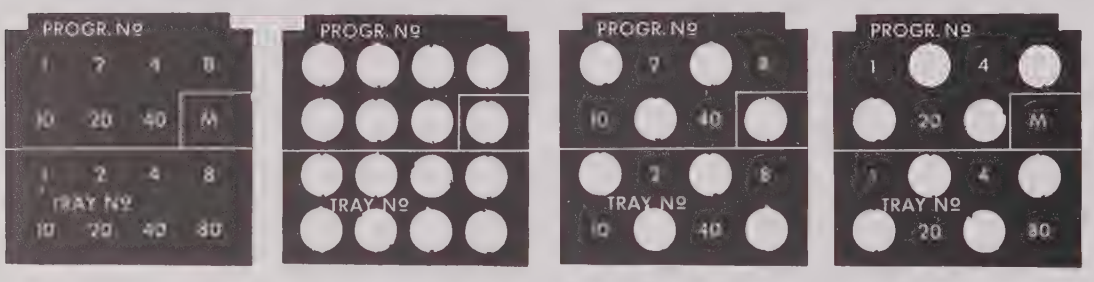
Fig. 7.6.1.2. Grab arm movement

NAME: TEST 1
PROGR. 00
TRAY 00

NAME: TEST 2
PROGR. FF
TRAY FF

NAME: TEST 3
PROGR. A5
TRAY A5

NAME: TEST 4
PROGR. 5A
TRAY 5A

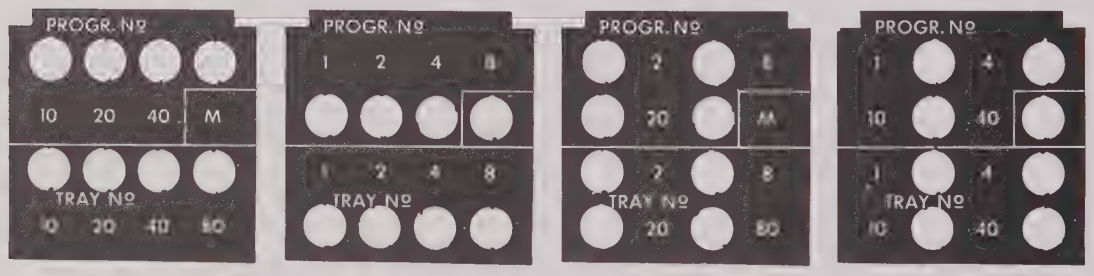


NAME: TEST 5
PROGR. OF
TRAY OF

NAME: TEST 6
PROGR. F0
TRAY F0

NAME: TEST 7
PROGR. 55
TRAY 55

NAME: TEST 8
PROGR. AA
TRAY AA



RD 3729

Fig. 7.6.1.3. Optical reader test identification cards

7.6.3. Software commands

The following commands can be used when a sample changer or loader is fitted to the spectrometer. These are normally used in the sample measurement procedures, but they can be used to check the changer operation.

▲LTU i	Load sample from the changer into turret position i, where i = 1 to 4.
▲UTU i	Unload sample from turret position i to the changer, where i = 1 to 4.
▲STY i	Search for tray number i = 1 to 165 (loaded on tray program card). The changer will search until position 1 of the selected tray number i is in position ready to be loaded into the spectrometer.
▲MTY i	Move the tray to bring the sample position i ready for loading, where i = 1 to 6.
▲FRT	Fetch the tray of reference samples, stored in the reference tray option PW1505/00.
▲SRT	Store the reference tray (PW1500/00/05/06 with reference tray option PW1505/00).
ASC i (j)	Automatic sample changer to be used for the measurement of samples up to, and including, tray i, where i = 1 to 165. The optional argument j is an identification number from 0 to 999, which is raised by 1 for each new sample loading.
RCS i	Recycle sample changer measurements i times. i = as RCM command. Use RES to reset.
PTY i	Programmed tray i, where i = 1 to 165, can have a separate measurement program and sample identification for each sample.

Stop commands

/	Stop measurement program (or other action) immediately slash and carriage return given.
/S	Stop the scaler/timer operation and print the results. If a further measurement is programmed, this will start after the printout of the results.
/M	Stop after the completion of the measuring program of the samples. Used to interrupt a measurement routine using the automatic sample changer. The original recycling command is not reset.
/T	Stop after the complete measurement of samples in a tray in the loading position of the automatic sample changer. The next start measurement command will commence measurement of the samples in the next tray.
BREAK or INTERRUPT	Stop immediateiy, interrupt any action. This action is preferred over /c.r.

8. ILLUSTRATED PARTS LIST

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8.0 GENERAL

8.0.1 PW1400/00 system

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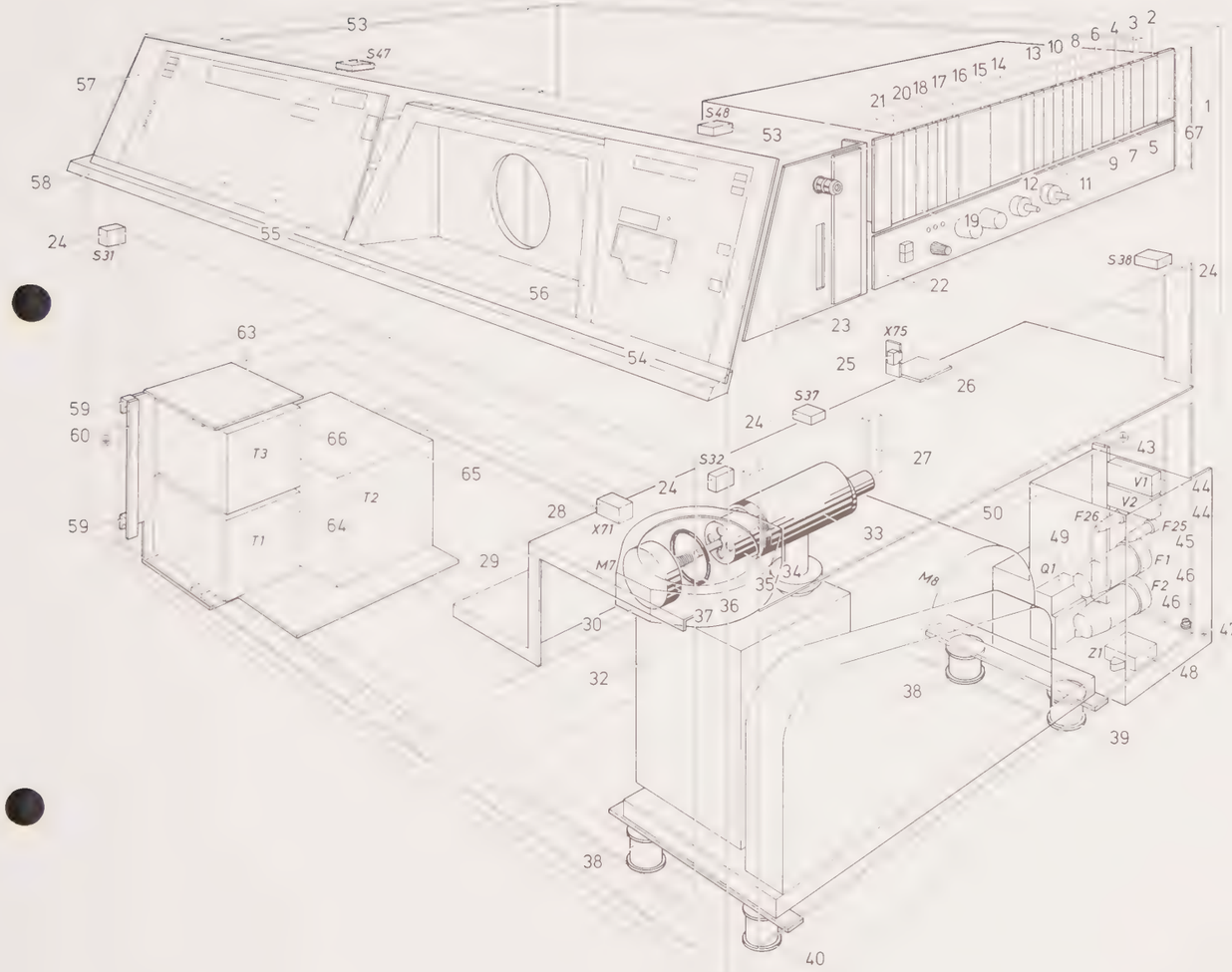
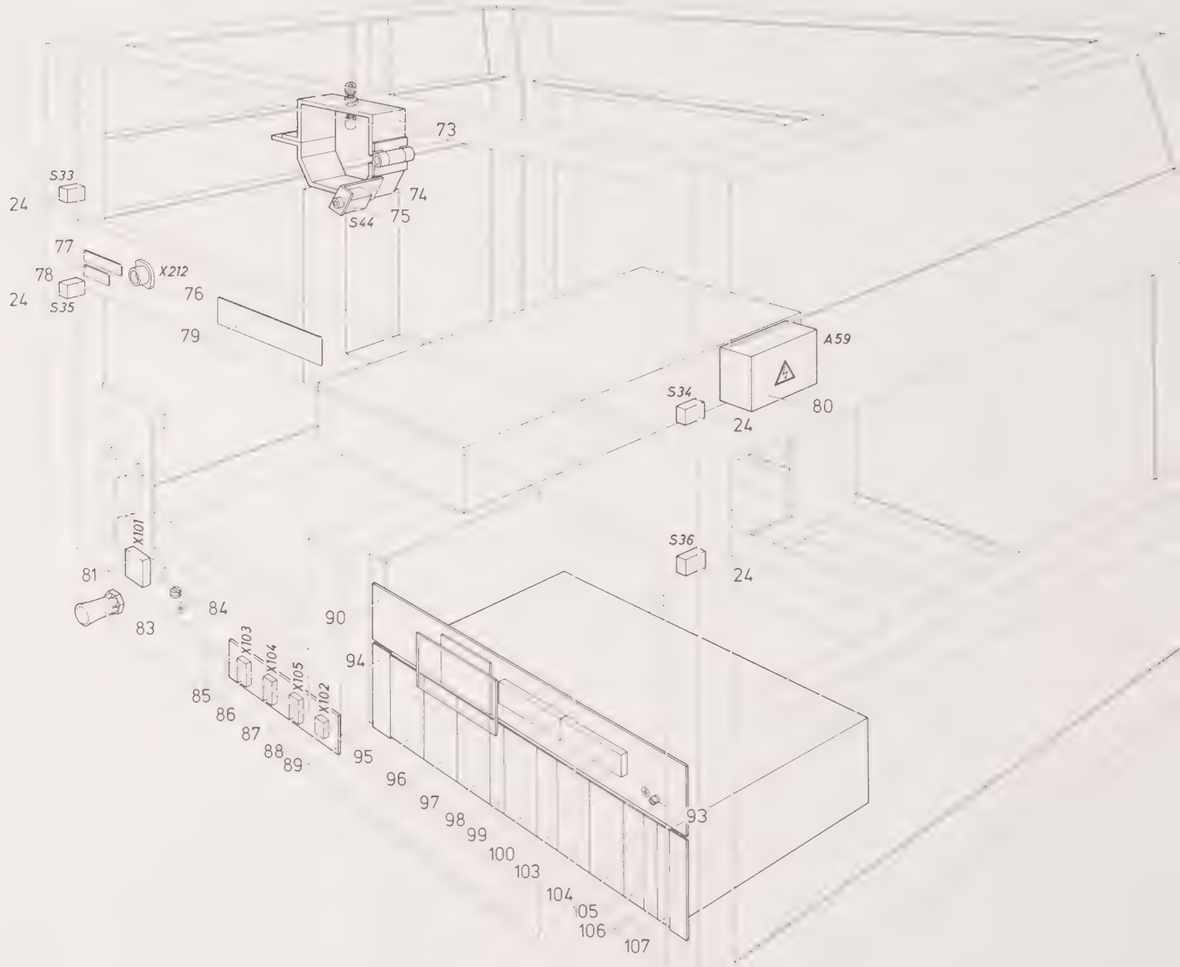
2,3	Amplifier/analyser 1,2	A1, A2	8– 14	
4	Window control	A3	8– 16	
5	Ratemeter	A4	8– 18	
6	Counter timer	A5	8– 22	
7	Stepping motor control	A6	8– 24	
8	Position control	A7	8– 26	
9	Spectrometer control 1	A8	8– 28	
10	Spectrometer control 2	A9	8– 30	
11	Spectrometer control 3	A10	8– 32	
12	Sample changer control	A11		5322 694 14378
14	Power supply +5V 2A	A13	4–312	PE 1271/00
	Crowbar			PE 1379/00
15	Power supply +12V	A14	4–312	PE 1274/00
	Crowbar			PE 1378/00
16	Bus interface	A15	8– 34	
17	CPU – ROM	A16	8– 36	
18	RAM	A17	8– 40	
20,21	Serial interface 1,2	A19, A20	8– 42	
22	Adjusting panel 2		8– 74	
23	Adjusting panel 1		8–123	
24	Safety switch S31-S38			5322 271 34193
25	Connector block X75			
27	Connector strip KK4			5322 290 64215
28	Connector block X71			5322
30	FAN M7			5322 361 14148
34	Aluminum oxide pellets in tin of 1 kg			5322 390 84003
38	Shock absorber blue			5322 529 10129
39	Shock absorber yellow			5322 529 10131
40	Shock absorber green			5322 529 10132
44	Sollid relay 240-D10			5322 280 74108
45	Fuse holder 5x20 mm			5322 256 34081
	Fuse 1,6 adel 5x20 mm glass F25, F26			4822 253 30024
46	Fuse holder E27			5322 256 40037
	Fuse 10A delayed E27, F1, F2			5322 254 40003
	Fuse fitting screw E27 16A			5322 256 54005
48	R.F. filter CORCOM 10K6	Z1		
49	Mains contactor 24V50/60 Hz			5322 280 44049
53	Microswitch	S47, 48		
54	Front panel right		8– 73	
55	Front panel left		8– 72	
56	Cap unit		8–116	
64	Transformer TE 2535	T1		5322 146 14153
65	Transformer TE 3235	T2		5322 146 14154
66	Transformer TE 2550	T3		5322 146 84011
75	Safety socket	S44		5322 267 30231

item	description	unit	see page	ordering code
76	Connector socket Tuchel 10A 3111-000 female	X212		5322 267 44009
	Cable connector plug X212 Amphenol 4 pole male			5322 264 44007
80	Detector connector Pcb	A59	8– 76	
85	Connector socket	X103	8– 86	
86	Connector socket	X104	8– 86	
87	Connector socket	X105	8– 86	
88	Connector socket	X106	8– 86	
90	Fuse panel		8– 81	
95	H.V. supply 3000V	A41	8– 60	
96	H.V. supply 1500V	A40	8– 58	
97	Generator control + safety	A39	8– 56	
98	Miscellaneous control	A38	8– 52	
99	Stepping motor supply + driver	A37	8– 50	
100	Motor driver	A36	8– 48	
103	Power supply		4–305	PE 1813/00
	Crowbar			PE 1379/00
104	Power supply	A34	8– 46	
106/107	Coil driver	A31, 32	8– 44	

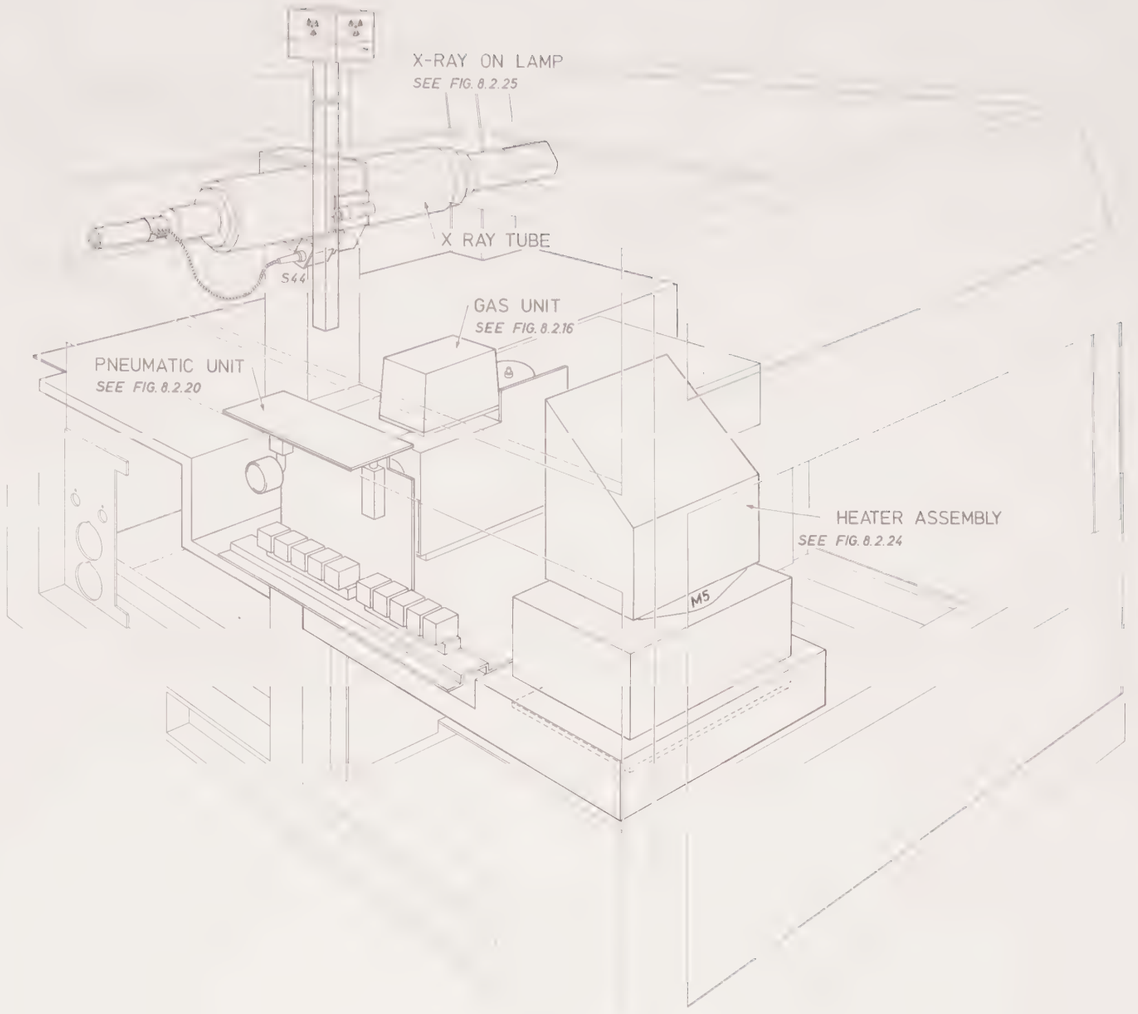


Front view



Rear view

Fig. 8.0.1. PW1400/00 System



Rear view

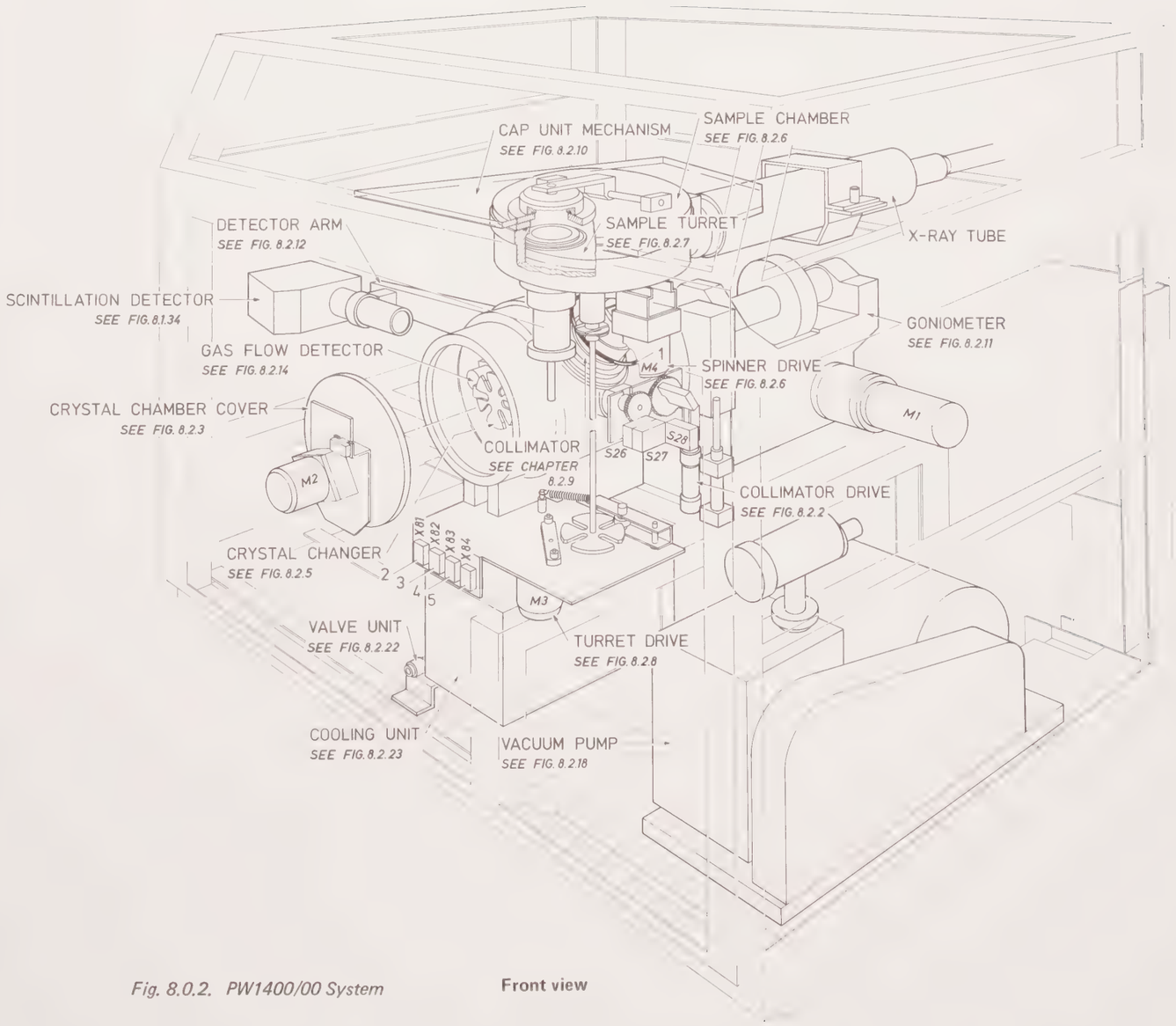


Fig. 8.0.2. PW1400/00 System

Front view

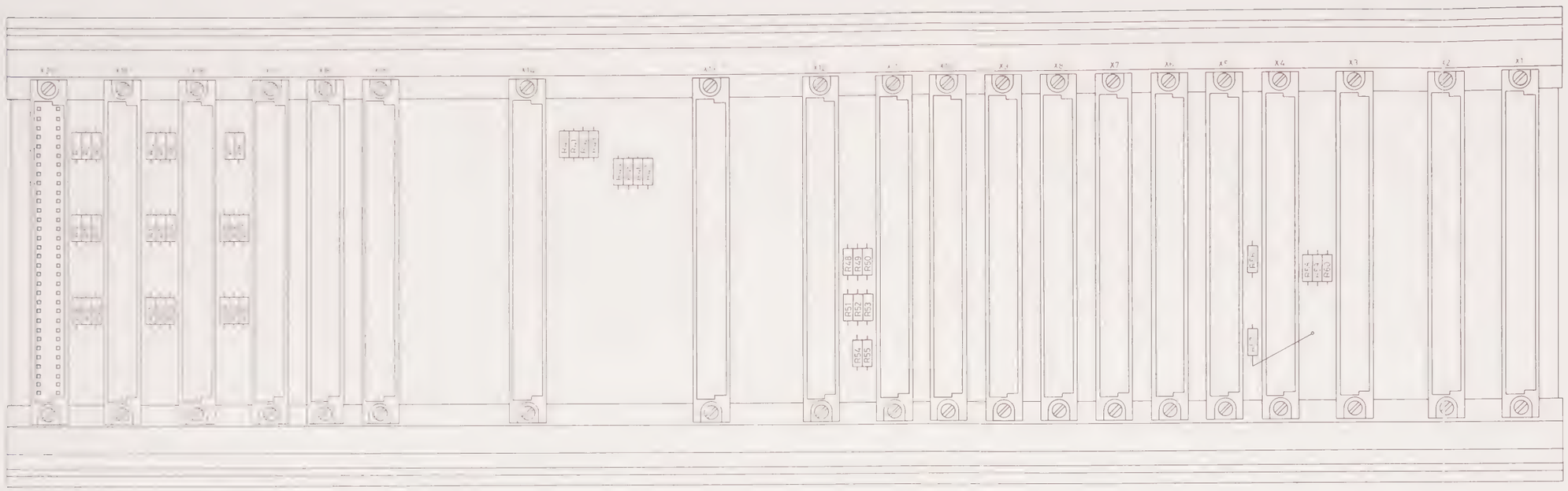
8.0.2 PW 1400/00 SYSTEM

item	Description	unit	see page	ordering code
1	O-ring			
2	Connector block	X81	8– 86	
3	Connector block	X82	8– 86	
4	Connector block	X83	8– 86	
5	Connector block	X84	8– 86	

8.1. ELECTRICAL

8.1.1. Motherboard

	Factory code 4022 332 82400			Ordering code 5322 694 14362
Item	*Description*			*Ordering code*
Resistors				
R1-60	100 k	5 %	CR25	4822 110 63161



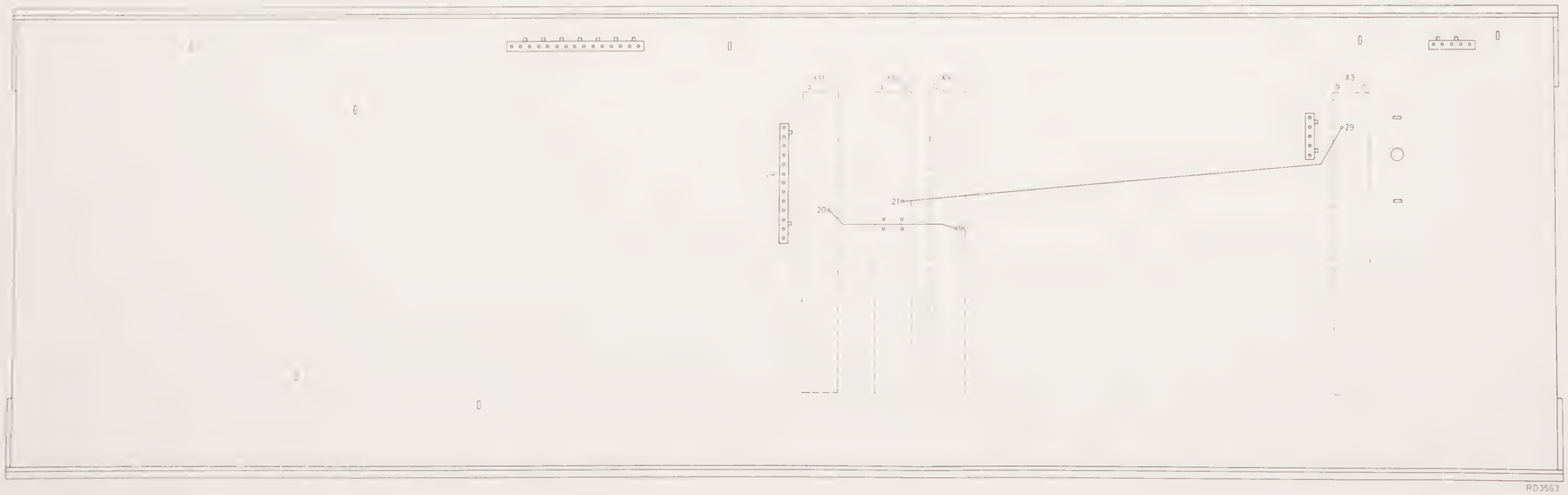


Fig. 8.1.1. Motherboard pcb

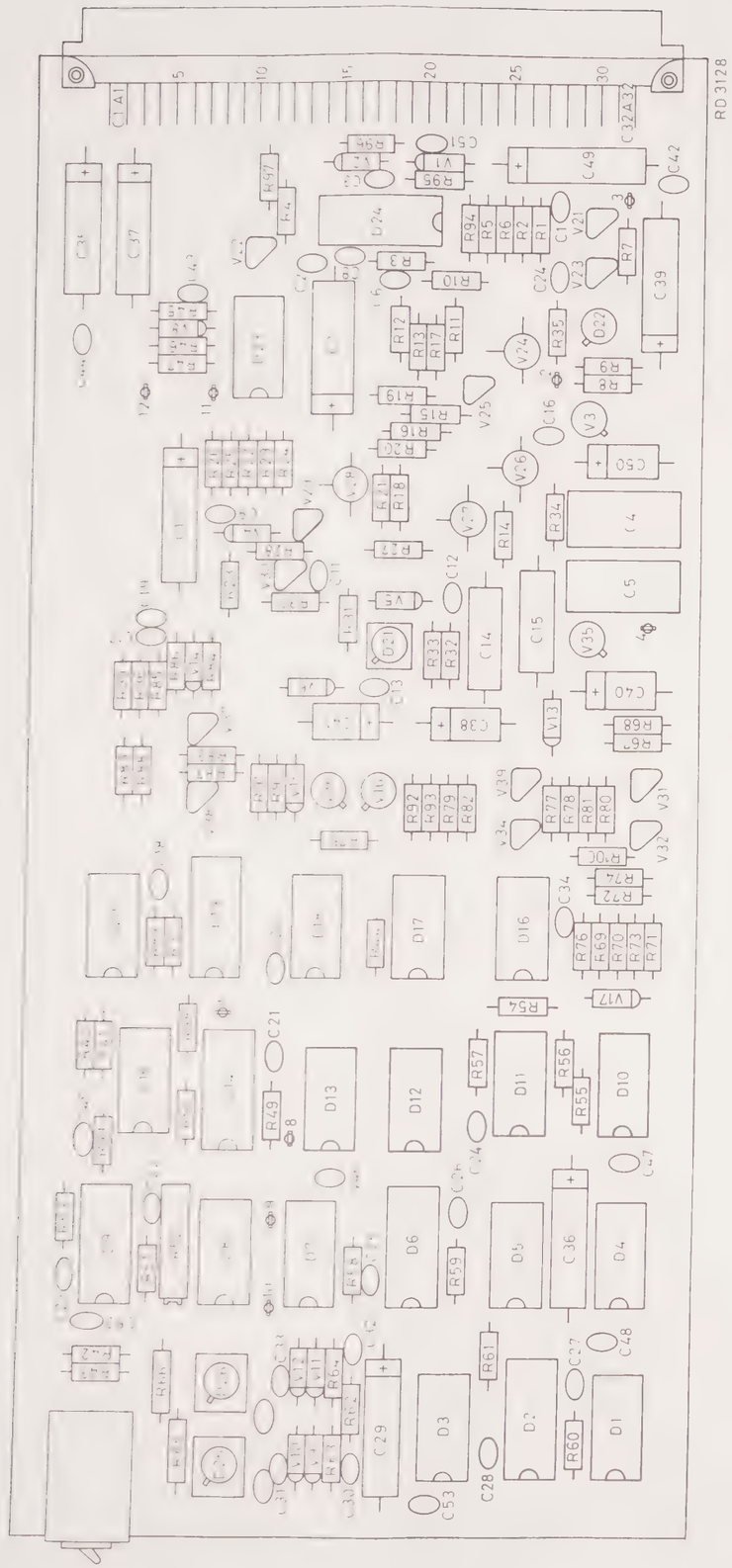


Fig. 8.1.2. Amplifier analyser pcb

8.1.2. Amplifier analyser pcb A1, A2

Factory code 4022 332 82310

Ordering code 5322 694 14331

Item	*Description*	*Ordering code*
Capacitors		
C1, 2, 6, 9, 13, 16, 17, 19, 20, 31, 33, 34, 44, 45, 46, 53	22 nF −20 + 80 % 40 V	4822 122 30103
C3, 27, 28	8,2 pF 0,25 pF 100 V	4822 122 31052
C4, 5	1 µF 10 % 100 V	5322 121 40197
C10, 29, 37, 39 49	68 µF −10 +50 % 16 V	5322 124 20377
C11	15 pF 2 % 100 V	2222 631 10159
C12	4,7 nF 10 % 100 V	4822 122 30128
C14, 15	10 nF 1 % 63 V	5322 121 54154
C18, 23	82 pF 2 % 100 V	5322 122 34094
C21, 26, 30, 32	47 pF 2 % 100 V	4822 122 31072
C22	6,8 pF 0,25 pF 100 V	4822 122 31049
C25, 42, 43	33 pF 2 % 100 V	4822 122 31067
C35, 36	150 µF −10 +50 % 16 V	4822 124 20454
C38, 40, 41, 50, 7	33 µF −10 +50 % 16 V	4822 124 20468
C51, 52	120 pF 2 % 100 V	4822 122 30093
C47, 48, 54	47 µF −10 +50 % 10 V	4822 124 20678
C8	4,7 pF 0,25 pF 100 V	2222 631 09478
C24	220 pF 10 % 100 V	4822 122 30094
Integrated circuits		
D1, 5, 7, 12	N74LS00N	5322 209 84823
D2, 6, 9, 14	SN74LS123N	5322 209 85602
D3	N7406N	5322 209 84073
D4, 15	N74LS132N	5322 209 85201
D8	N74LS90N	5322 209 85255
D10, 11, 17, 18	NE521N	5322 209 14441
D13	N74LS10N	5322 209 84996
D16, 23	LM324N	5322 209 85582
D19	SD5000B	5322 209 85748
D20	HEF4081BP	5322 209 14054
D21	UA710CA/SN72710L-00	5322 209 84242
D22	NE536T/CA3140S	5322 209 85566
D24	Integrated circuit, special	5322 209 85484
D25, 26	LM308T	5322 209 84659
Resistors		
R1	4k42 1 % MR25	5322 116 50556
R13, 26, 35, 49, 58-61, 69-71, 73, 75. 78, 80, 86 95, 96	10 k 1 % MR25	5322 116 54619
R3	6k49 1 % MR25	5322 116 54603
R7, 10, 46, 29, 11, 20	1k96 1 % MR25	5322 116 54571
R5, 6	162 E 1 % MR25	5322 116 50417
R8, 76, 90, 93	4k22 1 % MR25	5322 116 50729
R9, 92	7k87 1 % MR25	5322 116 50458
R12, 16, 25, 50, 51, 85	5k11 1 % MR25	5322 116 54595
R14, 18, 27, 30, 36, 39	100 E 1 % MR25	5322 116 54469

Item	*Description*			*Ordering code*
R15	825 E	1 %	MR25	5322 116 54541
R17, 24	19k6	1 %	MR25	5322 116 54641
R19	3k48	1 %	MR25	5322 116 54585
R21	348 E	1 %	MR25	5322 116 54515
R22, 2	7k5	1 %	MR25	5322 116 54608
R23	3k16	1 %	MR25	5322 116 50579
R28, 63, 64	261 E	1 %	MR25	5322 116 54502
R31, 41-43, 83, 87	31k6	1 %	MR25	5322 116 54657
R32, 33, 72, 74, 84, 88	100 k	1 %	MR25	5322 116 54696
R34, 38, 44, 77, 81, 97, 94, 77	1 k	1 %	MR25	5322 116 54549
R37	11 k	1 %	MR25	5322 116 54623
R45	2k74	1 %	MR25	5322 116 50636
R52	30k1	1 %	MR25	5322 116 54655
R47, 4	4k02	1 %	MR25	5322 116 54592
R53	20 k	10 %	1 W	5322 103 14065
R54	1k4	1 %	MR25	5322 116 54562
R55, 56	115 E	1 %	MR25	5322 116 54476
R57	383 E	1 %	MR25	5322 116 54518
R65, 66	1 M	1 %	MR30	5322 116 54188
R68, 89	12k1	1 %	MR25	5322 116 50572
R91	8k25	1 %	MR25	5322 116 54558
R98	3k83	1 %	MR25	5322 116 54589
R62	649 E	1 %	MR25	5322 116 54532
R82, 79	40k2	1 %	MR25	5322 116 54665
R99	226 E	1 %	MR25	5322 116 54497
R100	205 k	1 %	MR25	5322 116 54727
Switches				
S1	Tumbler switch			5322 277 14311
Diodes				
V1, 2, 4, 5, 9-13, 15	BAW62			4822 130 30613
V3, 16	BAV45			5322 130 34037
V6, 14	BZX79-C6V2			4822 130 34167
V8	BZV12			5322 130 34269
V17	BZX79-C6V8			5322 130 30768
Transistors				
V21-23, 31, 34	BC547			4822 130 44257
V24, 26, 28	BFR90			5322 130 44179
V25, 29	BF324			5322 130 44396
V30, 27	BF199			4822 130 44154
V32, 33, 37, 38	BC557			4822 130 44256
V35, 36	BFW13			5322 130 40516

8.1.3. Window control pcb A3

Factory code 4022 332 82350

Ordering code 5322 694 14332

Item	*Description*			*Ordering code*
Capacitors				
C1, 2	33 µF	–10 + 50 %	16 V	4822 124 20468
C3, 4	22 nF	–20 + 80 %	40 V	4822 122 30103
C5	100 nF	10 %	100 V	5322 121 40323
C6-11	100 pF	2 %	100 V	4822 122 31081
Integrated circuits				
D1, 5, 9-11	UA741CN			5322 209 85254
D2-4, 6-8	LM308T			5322 209 84659
D12-18	SD5000B			5322 209 85748
D19, 33	HEF4556BP			4822 209 10004
D20-22, 24, 25, 27	HEF40192BP			5322 209 14184
D23, 26	HEF4539BP			5322 209 14442
D28, 34	HEF4011BP			5322 209 14046
D29, 31, 35	HEF4049BP			5322 209 14049
D30	HEF4518BP			5322 209 14064
D32	HEF4027BP			5322 209 14055
Resistors				
R1	1 k	10 %	0,75 W	5322 103 10023
R2, 3, 22, 35, 45, 46, 48, 75, 78, 79, 81, 83, 84, 90	1 k	1 %	MR25	5322 116 54549
R19, 21, 32, 34	1 k	0,1 %	MB24E	5322 116 50747
R4	2k05	1 %	MR25	5322 116 50664
R6, 7, 9, 11, 12, 16, 17, 24, 25, 29, 30	100 k	1 %	MR25	5322 116 54696
R13, 18, 26, 31	5k11	0,1 %	MR24E	5322 116 54792
R8	5k11	1 %	MR25	5322 116 54595
R14, 27, 37-40, 43, 44, 76, 77, 82, 85-89		1 %	MR25	5322 116 54619
R20, 36, 41	10 k	10 %	0,75 W	5322 103 14026
R49	100 E	1 %	MR25	5322 116 54469
R50, 55, 60, 65, 70	102 k	1 %	MR25	5322 116 54697
R51, 56, 61, 66, 71	348 E	1 %	MR25	5322 116 54515
R52, 57, 62, 67, 72	12k4	1 %	MR25	5322 116 54626
R53, 58, 63, 68, 73	51k1	1 %	MR25	5322 116 50672
R54, 59, 64, 69, 74	25k5	1 %	MR25	5322 116 54649
R33	2 k	10 %		2122 003 00052
Diodes				
V1	BZV14			5322 130 34568
Transistors				
V2, 3	BCY56			5322 130 40325
V5-7	BSX20			5322 130 40417

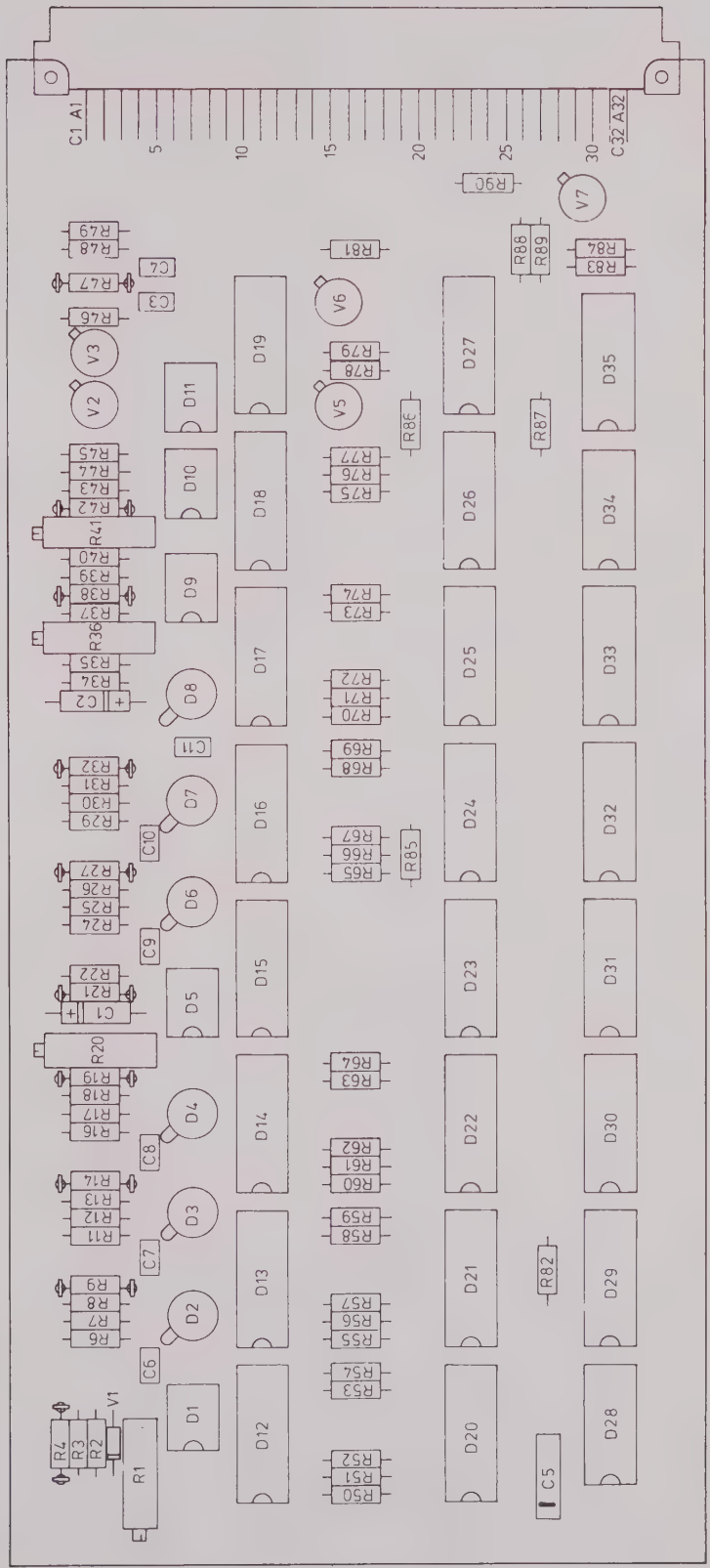


Fig. 8.1.3. Window control pcb

8.1.4. Ratemeter pcb A4

Factory code 4022 332 82320 — Ordering code 5322 694 14333

Item	*Description*			*Ordering code*
Capacitors				
C1	120 pF	2 %	100 V	4822 122 30093
C2	100 pF	1 %	630 V	4822 121 50562
C3	820 pF	1 %	250 V	5322 121 54072
C4	22 nF	−20 + 80 %	40 V	4822 122 30103
C5, 22	33 nF	10 %	250 V	5322 121 44025
C7	100 µF	−10 + 50 %	10 V	4822 124 20462
C8	220 nF	10 %	100 V	4822 121 40232
C10-15	12 pF	2 %	100 V	4822 122 31056
C16, 18	1 µF	10 %	100 V	5322 121 40197
C17	680 nF	10 %	100 V	5322 121 40233
C19, 9	330 nF	10 %	100 V	4822 121 40257
C20	150 nF	10 %	100 V	4822 121 40231
C21, 23, 24, 27-29	100 nF	10 %	100 V	5322 121 40323
C25, 30	68 µF	−10 + 50 %	16 V	5322 124 20377
C26	150 µF	−10 + 50 %	16 V	4822 124 20454
C31	180 pF	2 %	100 V	4822 122 31172
Integrated circuits				
D1	HEF4051BP			5322 209 14212
D2	HEF4071BP			5322 209 14053
D3,4	HEF4052BP			5322 209 14233
D5	HEF4556BP			4822 209 10004
D6	HEF4042BP			5322 209 14071
D7	HEF4027BP			5322 209 14055
D8	HEF4029BP			5322 209 14057
D9	HEF4555BP			5322 209 14188
D10	HEF4049BP			5322 209 14049
D11	HEF4081BP			5322 209 14054
D12, 13	HEF4001BP			5322 209 14045
D14	HEF4528BP			5322 209 14191
D15	HEF4085BP			5322 209 14058
D16	HEF4518BP			5322 209 14064
D17	N14LS26N			5322 209 85832
D18	N74LS90N			5322 209 85255
D19	LM324N			5322 209 85582
D20	N74LS123N			5322 209 85602
D21	NE536T			5322 209 85566
Resistors				
R2, 52, 53, 91	10 k	1 %	MR25	5322 116 54619
R3	2k61	1 %	MR25	5322 116 50671
R4, 5, 90	3k48	1 %	MR25	5322 116 54585
R6	215 E	1 %	MR25	5322 116 50457
R9	30E1	1 %	MR25	5322 116 50904
R10, 58, 63, 68, 73, 78, 83	1 M	5 %	CR25	4822 110 63187
R11, 12, 46-50, 54	12k1	1 %	MR25	5322 116 50572
R13-15	1 M	1 %	MR30	5322 116 54188
R16, 23-25	100 E	1 %	MR25	5322 116 54469

Item	*Description*			*Ordering code*
R17	10 k	20 %	0,05 W	4822 100 10035
R18	5k11	1 %	MR25	5322 116 54595
R26	1k47	1 %	MR25	5322 116 50635
R21	7k5	1 %	MR25	5322 116 54608
R27	147 E	1 %	MR25	5322 116 50766
R28, 29	226 k	1 %	MR25	5322 116 54729
R30-33	21k5	1 %	MR25	5322 116 50451
R34, 59, 64, 69, 74, 79, 84	10 M	10 %	CR25	4822 110 63214
R35	750 E	1 %	MR25	5322 116 54536
R36	4k22	1 %	MR25	5322 116 50729
R37-45	511 k	1 %	MR25	5322 116 55258
R51	100 k	1 %	MR25	5322 116 54696
R55, 60, 65, 70, 75, 80	5k62	1 %	MR25	5322 116 54011
R56, 61, 66, 71, 76, 81	1k78	1 %	MR25	5322 116 50515
R57, 62, 67, 72, 77, 82	23k7	1 %	MR25	5322 116 54646
R85, 87	4E7	5 %	CR25	4822 110 63045
R86	2E2	5 %	CR25	4822 110 63036
R88, 89, 93	1 k	1 %	MR25	5322 116 54549
R19	82k5	1 %	MR25	5322 116 54689
R92	3M9	10 %	CR25	4822 110 63203
Transistors				
V1	2N2907			5322 130 40218
V2	BSV78			5322 130 44093
V5, 18-23	BC557			4822 130 44256
V7, 8, 17	BC547			4822 130 44257
V35-40	BSV80			5322 130 34044
Diodes				
V3, 4, 6, 11-16, 24-34, 41-46	BAW62			4822 130 30613
V9	BZX75-C2V1			5322 130 34049
V10	BZX79-C6V2			4822 130 34167

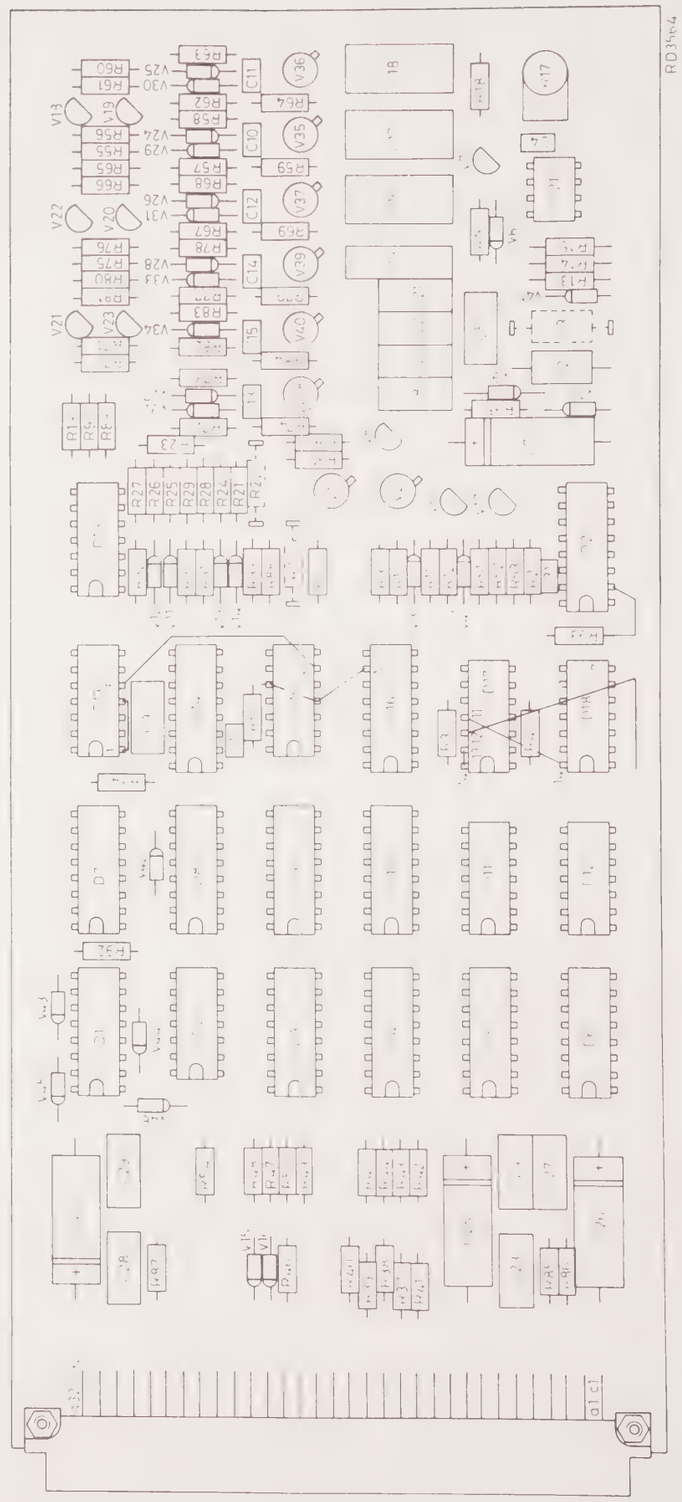


Fig. 8.1.4. Ratemeter pcb

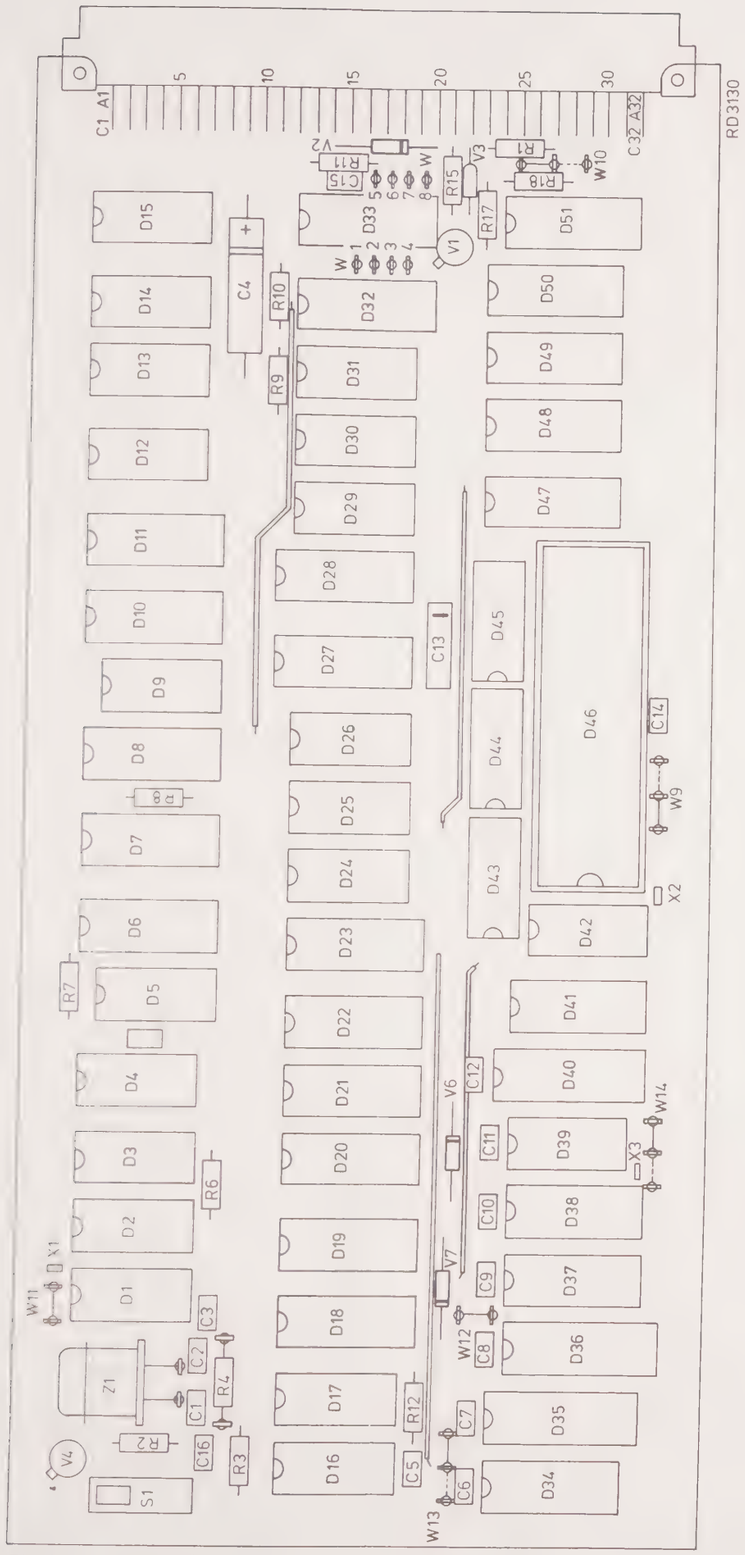


Fig. 8.1.5. Counter/timer pcb

8.1.5. Counter-timer pcb A5

Factory code 4022 332 82360

Ordering code 5322 694 14334

Item	*Description*			*Ordering code*
Capacitors				
C1, 2	100 pF	2 %	100 V	4822 122 31081
C6-12	10 nF	−20 +80 %	40 V	4822 122 30043
C4	33 µF	−20 +80 %	25 V	5322 124 24098
C5, 14	1 nF	−20 +80 %	40 V	4822 122 30027
C13	10 nF	10 %	400 V	5322 121 44002
C15	22 nF	−20 +80 %	40 V	4822 122 30103
C16, 17	3,9 nF	10 %	100 V	4822 122 30098
Integrated circuits				
D1, 12	HEF4069UBP			5322 209 14128
D2, 13, 43	HEF4013BP			5322 209 10002
D3, 17, 25	HEF4011BP			5322 209 14046
D4	HEF4075BP			5322 209 14067
D5, 9, 24, 26	HEF4082BP			5322 209 14213
D6, 8, 22, 23, 27	HEF4519BP			5322 209 14217
D7, 10, 11	HEF4724BP			5322 209 14306
D14, 15	HEF4081BP			5322 209 14054
D16, 31	HEF4023BP			5322 209 14065
D18, 21	HEF4052BP			5322 209 14233
D19, 20, 38	HEF4518BP			5322 209 14064
D28	HEF4051BP			5322 209 14212
D29	HEF4071BP			5322 209 14053
D30, 42	HEF4073BP			5322 209 14066
D32, 48-51	HEF40097BP			5322 209 14433
D33	HEF4556BP			4822 209 10004
D34, 37	HEF4018BP			5322 209 14118
D35, 36, 40	GZF1201P/HEF4737UP			5322 209 84722
D39	HEF4001BP			5322 209 14045
D41, 47	HEF4050BP			5322 209 14068
D44	HEF4072BP			5322 209 14074
D45	HEF4075BP			5322 209 14067
D46	MK50395N			5322 209 14185
Resistors				
R15	511 E	1 %	MR25	4822 116 54525
R2	12k1	1 %	MR25	5322 116 50572
R3	1 k	1 %	MR25	5322 116 54549
R4	33k2	1 %	MR25	5322 116 50482
R7-10, 12, 17, 18, 1	10 k	1 %	MR25	5322 116 54619
R11	825 E	1 %	MR25	5322 116 54541
R6	20 k	1 %	MR25	5322 116 51048
Switches				
S1	Microsw	1 p 7 A	250 V	5322 271 34135
Transistors				
V1, 4	BSX20			5322 130 40417

Item	*Description*	*Ordering code*
Diodes		
V2	BZX75-C2V1	5322 130 34049
V3	BAW62	4822 130 30613
Crystals		
Z1	Crystal 8 MHz	5322 242 74072

8.1.6. Stepping motor control pcb A6

Factory code 4022 332 82340 — Ordering code 5322 694 14335

Item	*Description*			*Ordering code*
Capacitors				
C1	22 nF	–20 +80 %	40 V	4822 122 30103
C2	47 nF	10 %	250 V	5322 121 44138
C3	820 pF	10 %	100 V	4822 122 30135
C4	82 pF	2 %	100 V	4822 122 31078
C5	10 µF	–10 +50 %	63 V	4822 124 20475
C6-19	100 nF	10 %	100 V	5322 121 40323
C20, 21	120 pF	2 %	100 V	4822 122 30093
C22, 23	180 pF	10 %	100 V	4822 122 30113
Integrated circuits				
D1, 11, 22	HEF4047BP			5322 209 14125
D2, 3, 8	HEF4040BP			5322 209 14269
D4, 15, 16, 24	HEF4011BP			5322 209 14046
D5, 32	HEF4049BP			5322 209 14049
D6, 14, 23, 27	HEF4013BP			5322 209 10002
D7, 20	HEF4012BP			5322 209 14047
D9	HEF4051BP			5322 209 14212
D10	HEF4042BP			5322 209 14071
D12, 26	HEF4002BP			5322 209 14069
D13, 28	HEF4001BP			5322 209 14045
D17, 21	HEF4081BP			5322 209 14054
D18, 25	HEF4070BP			5322 209 14073
D19	HEF4015BP			5322 209 14216
D29	HEF4029BP			5322 209 14057
D30	HEF4028BP			5322 209 14056
D31	HEF4025BP			5322 209 14052
Resistors				
R1	1 M	5%	MR25	5322 116 54743
R3	75 k	1 %	MR25	5322 116 54686
R4, 14, 18, 22	22k6	1 %	MR25	5322 116 50481
R5, 7, 13, 15, 17, 2 20, 23-25	100 k	1 %	MR25	5322 116 54696
R6, 8, 10	6k81	1 %	MR25	5322 116 54012
R9, 11, 12	332 E	1 %	MR25	5322 116 54513
R16, 19, 21	33E2	1 %	MR25	5322 116 50527
R26, 28, 29, 30	10 k	1 %	MR25	5322 116 54619
R27	56k2	1 %	MR25	5322 116 54676
Diodes				
V1	BAW62			4822 130 30613

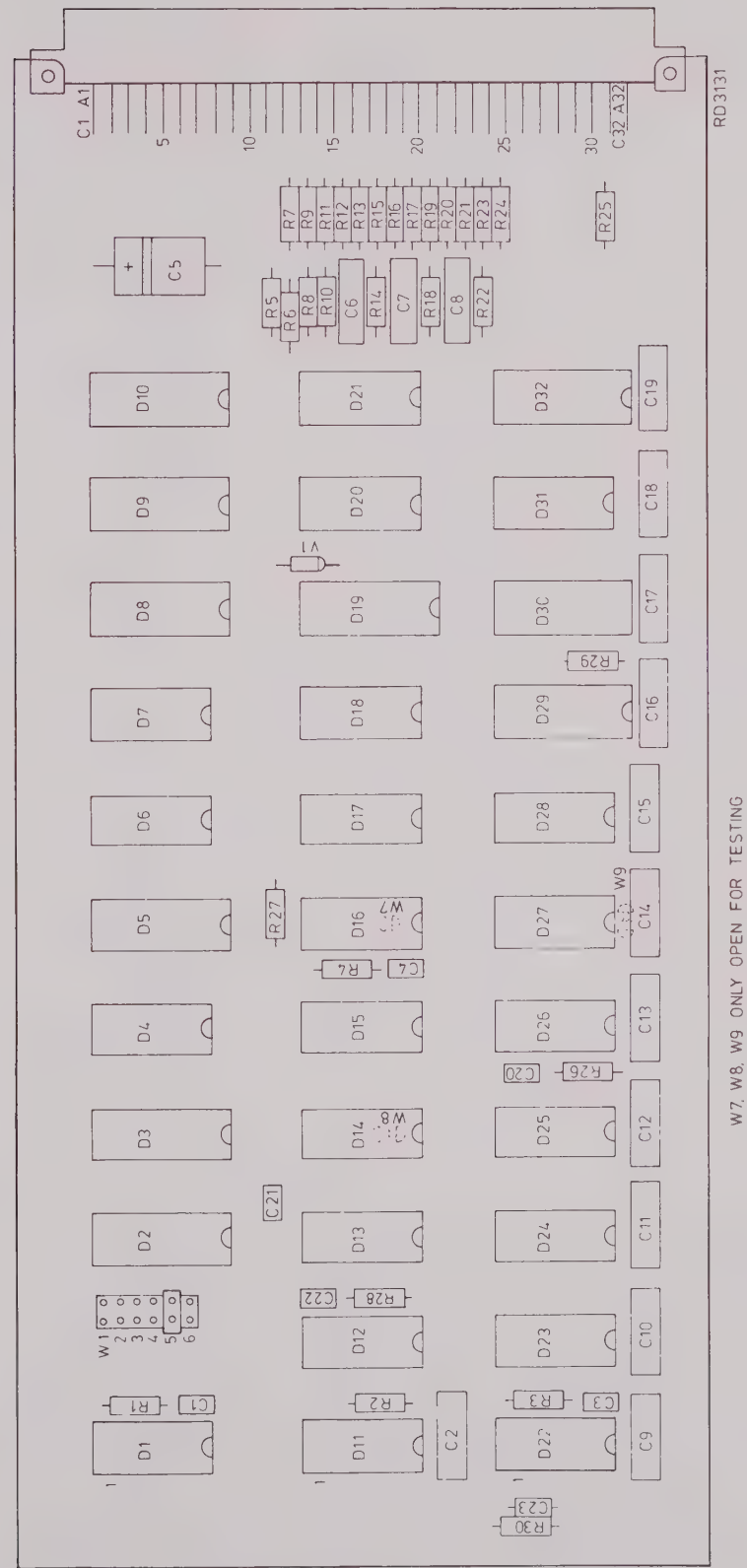


Fig. 8.1.6. Stepping motor control pcb

8.1.7. Position control pcb A7

Item	Description			Ordering code
	Factory code 4022 332 82330			Ordering code 5322 694 14336
Capacitors				
C1, 2, 6-8, 11-15	22 nF	−20 +80 %	40 V	4822 122 30103
C5	560 pF	2 %	100 V	4822 122 30126
C9	220 nF	10 %	100 V	4822 121 40232
C10	100 pF	2 %	100 V	4822 122 31081
Integrated circuits				
D1	HEF4023BP			5322 209 14065
D2, 3, 7, 13	HEF4013BP			5322 209 10002
D4, 14	HEF4049BP			5322 209 14049
D5, 8, 10, 18, 23	HEF4011BP			5322 209 14046
D6	HEF4051BP			5322 209 14212
D9	HEF4556BP			4822 209 10004
D11	HEF4025BP			5322 209 14052
D12	MK50395N			5322 209 14185
D15	HEF4028BP			5322 209 14056
D16, 17, 24, 25	HEF40097BP			5322 209 14433
D19, 21	HEF4002BP			5322 209 14069
D20	HEF4001BP			5322 209 14045
D22	HEF4081BP			5322 209 14054
Resistors				
R1	301 k	1 %	MR25	5322 116 54743
R2, 3, 6, 9, 10, 13-15	100 k	1 %	MR25	5322 116 54696
R4	60k4	1 %	MR25	5322 116 54679
R5	5k11	1 %	MR25	5322 116 54595
R7, 8	10 k	1 %	MR25	5322 116 54619
R11	15k4	1 %	MR25	5322 116 50479
R16-23	1 k	1 %	MR25	5322 116 54549
Diodes				
V1	BAW62			4822 130 30613

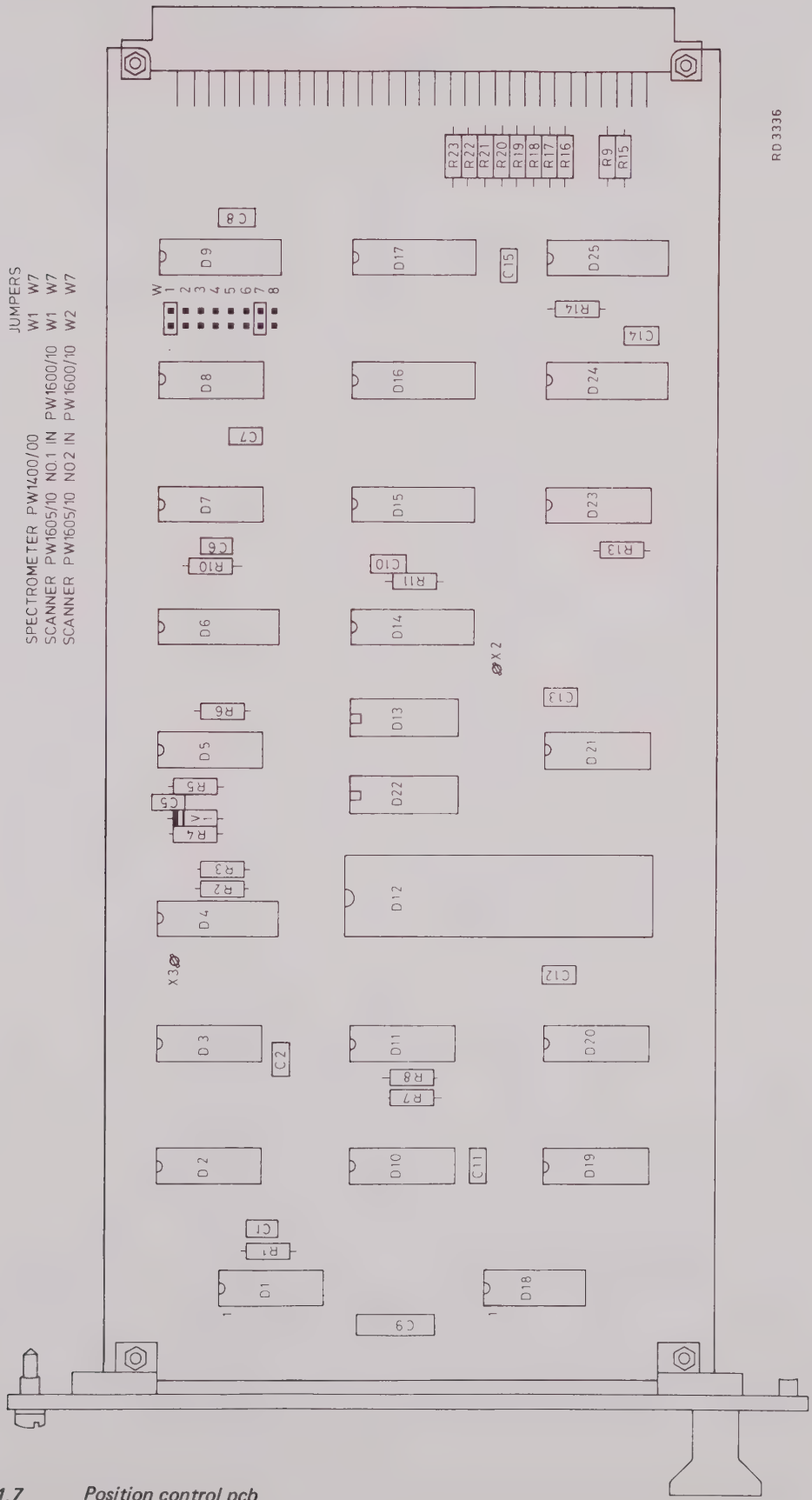


Fig. 8.1.7. Position control pcb

8.1.8. Spectrometer control 1 pcb A8

Factory code 4022 332 82370 — Ordering code 5322 694 14337

Item	*Description*			*Ordering code*
Capacitors				
C1, 2, 4, 15, 22-25	10 nF	−20 +80 %	40 V	4822 122 30043
C5, 12, 13	100 nF	10 %	100 V	5322 121 40323
C10	180 pF	10 %	100 V	4822 122 31172
C11	68 µF	−10 +50 %	16 V	5322 124 20377
C26	22 µF	−10 +50 %	25 V	4822 124 20698
C3	1 µF	−10 +50 %	63 V	5322 121 40197
C6-9, 16-21	1 µF	20 %	25 V	4822 124 20944
Integrated circuits				
D1	HEF4072BP			5322 209 14074
D2, 29, 30	HEF4081BP			5322 209 14054
D3	HEF4069UBP			5322 209 14128
D4, 18	HEF4001BP			5322 209 14045
D5, 25	HEF4071BP			5322 209 14053
D6, 7, 14, 15	HEF40097BP			5322 209 14433
D8, 16	HEF4556BP			4822 209 10004
D11	HEF4024BP			5322 209 14103
D10, 21	HEF4011BP			5322 209 14046
D12	HEF40175BP			5322 209 14406
D13, 17	HEF4528BP			5322 209 14191
D19, 28	HEF4013BP			5322 209 10002
D20	HEF4073BP			5322 209 14066
D22, 32, 34	HEF4093BP			5322 209 14186
D23, 24	SD5000N			5322 209 85748
D26	HEF4025BP			5322 209 14052
D27	HEF4724BP			5322 209 14306
D31	LM324N			5322 209 85582
D33	HEF4075BP			5322 209 14067
Resistors				
R2	1k24	0,25 %	MR24E	5322 116 54904
R1	1k87	0,25 %	MR24E	5322 116 55146
R3	3k40	0,25 %	MR24E	5322 116 55261
R4	5k11	0,25 %	MR24E	5322 116 54792
R5	301 E	0,25 %	MR24E	5322 116 55038
R6	3k52	0,25 %	MR24E	5322 116 55054
R7	7k06	0,25 %	MR24E	5322 116 55262
R10, 24, 50-59	100 k	1 %	MR25	5322 116 54696
R11, 12, 15-18, 20, 25, 34-39, 41, 42, 47, 48	10 k	1 %	MR25	5322 116 54619
R19	5k62	1 %	MR25	5322 116 54011
R21, 22	2k21	0,25 %	MR24E	5322 116 54171
R26-33	10 k	0,25 %	MR24E	5322 116 50748
R40, 13	1 M	1 %	MR30	5322 116 54188
R14	5k9	1 %	MR25	5322 116 50583
R43, 44, 46	1 k	1 %	MR25	5322 116 54549
R45	402 E	1 %	MR25	5322 116 54519
Diodes				
V1	BAW62			4822 130 30613

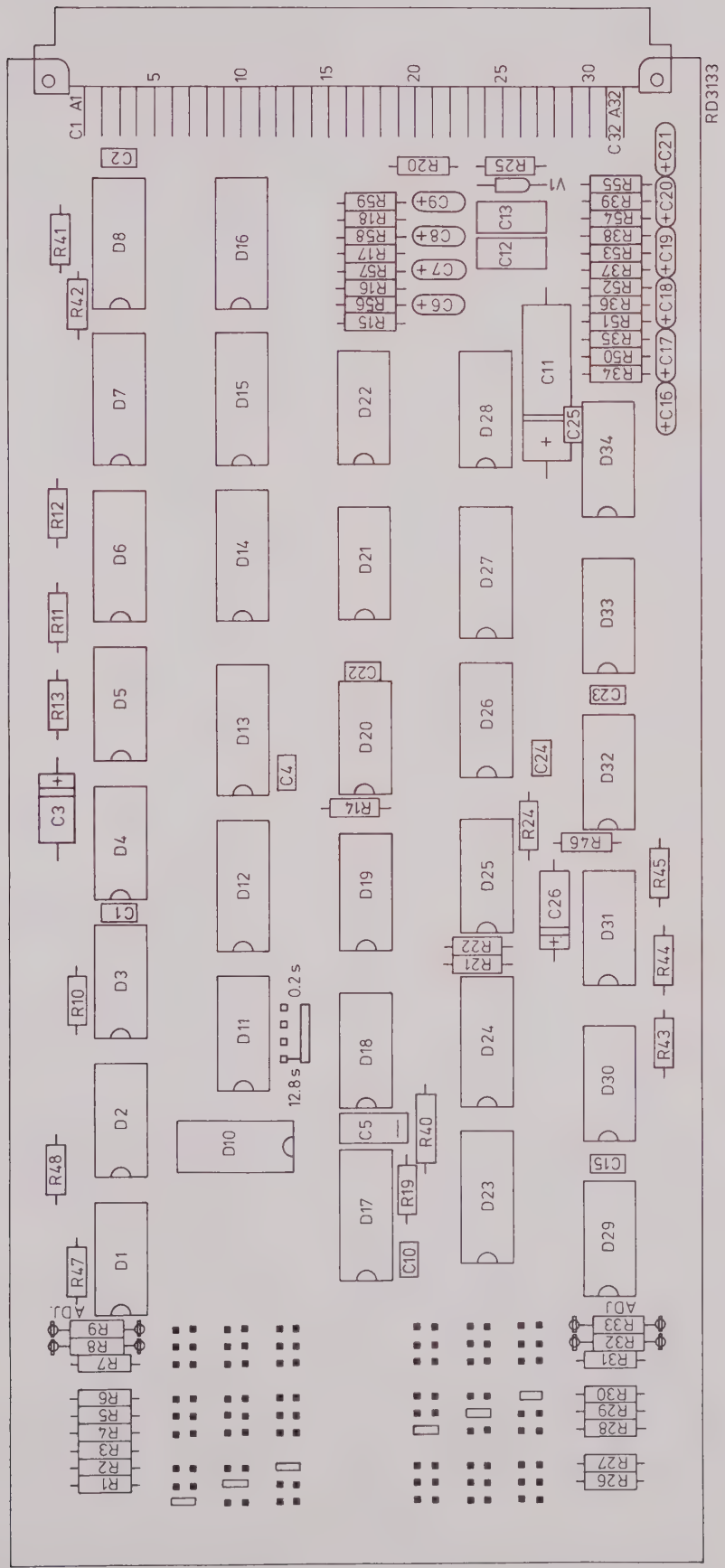


Fig. 8.1.8. Spectrometer control 1 pcb

8.1.9. Spectrometer control 2 pcb A9

Factory code 4022 332 82380

Ordering code 5322 694 14338

Item	*Description*			*Ordering code*
Capacitors				
C4	68 µF	−10 + 50 %	16 V	5322 124 24136
C6, 7	180 pF	10 %	100 V	4822 122 30113
C9, 10	10 nF	−20 +80 %	40 V	4822 122 30043
C14-21	1 µF	−20 +40 %	25 V	4822 124 20944
C2, 3, 5, 8, 11−13	68 nF	10 %	250 V	4822 121 41156
Integrated circuits				
D1	HEF4075BP			5322 209 14067
D2, 16, 18	HEF4724BP			5322 209 14306
D3, 6, 19	HEF4069UBP			5322 209 14128
D4, 20	HEF4081BP			5322 209 14054
D5	HEF4073BP			5322 209 14066
D7, 14, 22	HEF4071BP			5322 209 14053
D8	HEF4011BP			5322 209 14046
D9, 10	HEF4556BP			4822 209 10004
D11	HEF4024BP			5322 209 14103
D12, 17	HEF4528BP			5322 209 14191
D13	HEF4013BP			5322 209 10002
D21	HEF4072BP			5322 209 14074
D23-25	HEF40097BP			5322 209 14433
D26, 27	HEF4093BP			5322 209 14186
Resistors				
R1	59 k	1 %	MR25	5322 116 54678
R3, 4	1 M	5 %	CR25	4822 110 63187
R5	100 E	1 %	MR25	5322 116 54469
R6-12	12 k	1 %	MR25	5322 116 50572
R13-22	100 k	1 %	MR25	5322 116 54696
R2	10 k	1 %	MR25	5322 116 54619
Transistors				
V1	BCY59			5322 130 44073

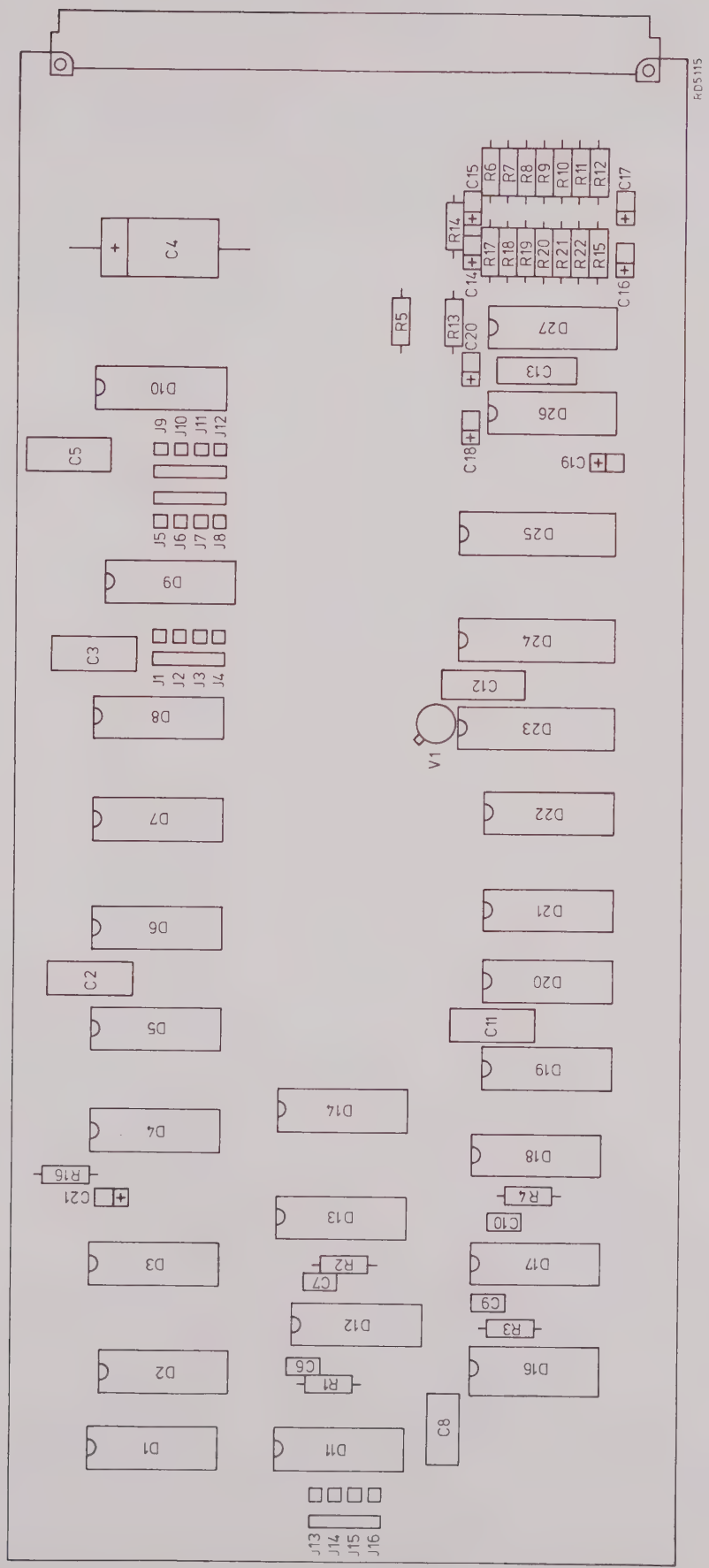


Fig. 8.1.9. Spectrometer control 2 pcb

8.1.10. Spectrometer control 3 pcb A10

	Factory code 4022 332 82390			Ordering code 5322 694 14339
Item	*Description*			*Ordering code*
Capacitors				
C1-7	68 nF	10 %	250 V	5322 121 41156
C8, 9	68 μF	−10 +50 %	16 V	5322 124 24136
Integrated circuits				
D2, 4, 14, 16	HEF40097BP			5322 209 14433
D6, 7	HEF40175BP			5322 209 14406
D8	HEF4069UBP			5322 209 14128
D9, 21	HEF4025BP			5322 209 14052
D10, 11	HEF4556BP			4822 209 10004
D18	HEF4071BP			5322 209 14053
D19	HEF4001BP			5322 209 14045
D20	HEF4013BP			5322 209 10002
D22	HEF40174BP			5322 209 14444
D23, 24	HEF4050BP			5322 209 14068
Resistors				
R1-6	11 k	1 %	MR25	5322 116 54623

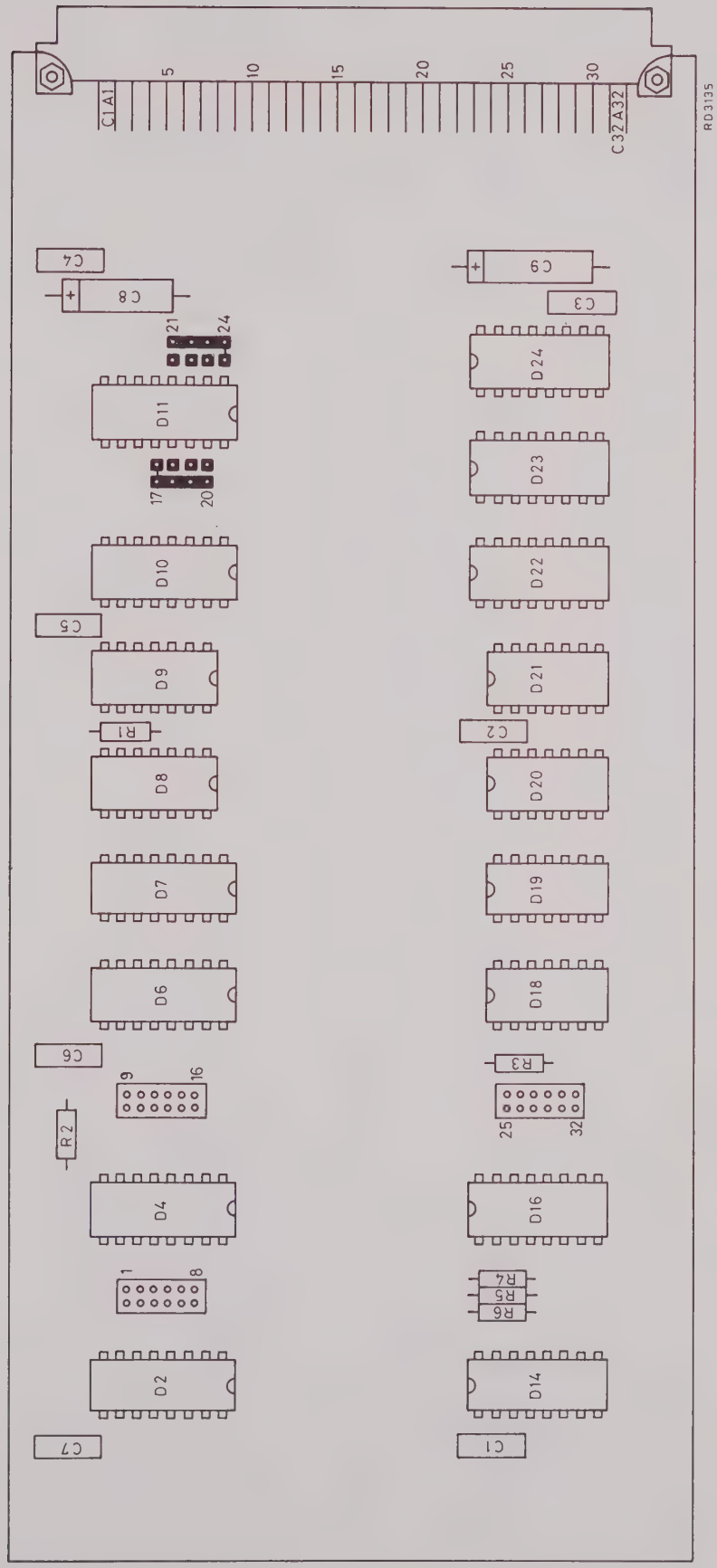


Fig. 8.1.10. Spectrometer control 3 pcb

8.1.11. Bus interface pcb A15

Factory code 4022 332 82300 — Ordering code 5322 694 14341

Item	*Description*			*Ordering code*
Capacitors				
C1-8, 11-14, 17, 18	10 nF	−20 +80 %	40 V	4822 122 30043
C9, 10	68 µF	−10 +50 %	16 V	5322 124 24136
C15, 16	100 nF	10 %	100 V	5322 121 40323
Integrated circuits				
D1	LM324N			5322 209 85582
D2, 15, 17	HEF4011BP			5322 209 14046
D3	HEF4017BP			5322 209 14048
D4	HEF4071BP			5322 209 14053
D5, 6, 14	HEF4081BP			5322 209 14054
D7	HEF4556BP			4822 209 10004
D8	Voltage reg 7805CU			5322 209 85535
D9	HEF4082BP			5322 209 14213
D10	HEF4013BP			5322 209 10002
D11	HEF4049BP			5322 209 14049
D12, 13, 20, 23, 29	HEF4104BP			5322 209 14443
D16, 18, 25, 27	HEF40097BP			5322 209 14433
D19, 26, 28	HEF4050BP			5322 209 14068
D21	HEF4044BP			5322 130 44698
D22	4532PC			5322 209 85849
D24	Voltage reg 7905CU			5322 209 85836
Source				
G1	NiCD battery 41B021AD00501			2422 526 01032
Resistors				
R1, 7, 14, 18, 28-34	47 k	5 %	CR25	4822 110 63152
R2, 4-6, 12, 15-17, 26, 27	1 k	5 %	CR25	4822 110 63107
R3, 19, 21, 9	2k7	5 %	CR25	4822 110 63118
R10, 11, 35	10 k	5 %	CR25	4822 110 63134
R13, 22-25	270 E	5 %	CR25	4822 110 63092
R20	560 E	5 %	CR25	4822 110 63101
Diodes				
V1, 8, 9, 20, 22, 23, 6	BAW62			4822 130 30613
V3	BZX75-C1V4			4822 130 34047
V4	BZX79-C8V2			4822 130 34382
V5	BZX75-C2V1			5322 130 34049
V7, 18	BZX79-C6V8			5322 130 34278
V11	BZX75-C3V6			5322 130 30765
V13-17	LED CQY95			4822 130 30923
V19	BZX79-C12			4822 130 34197
Transistors				
V12	BC547			4822 130 44257
V21	BC557B			4822 130 44568

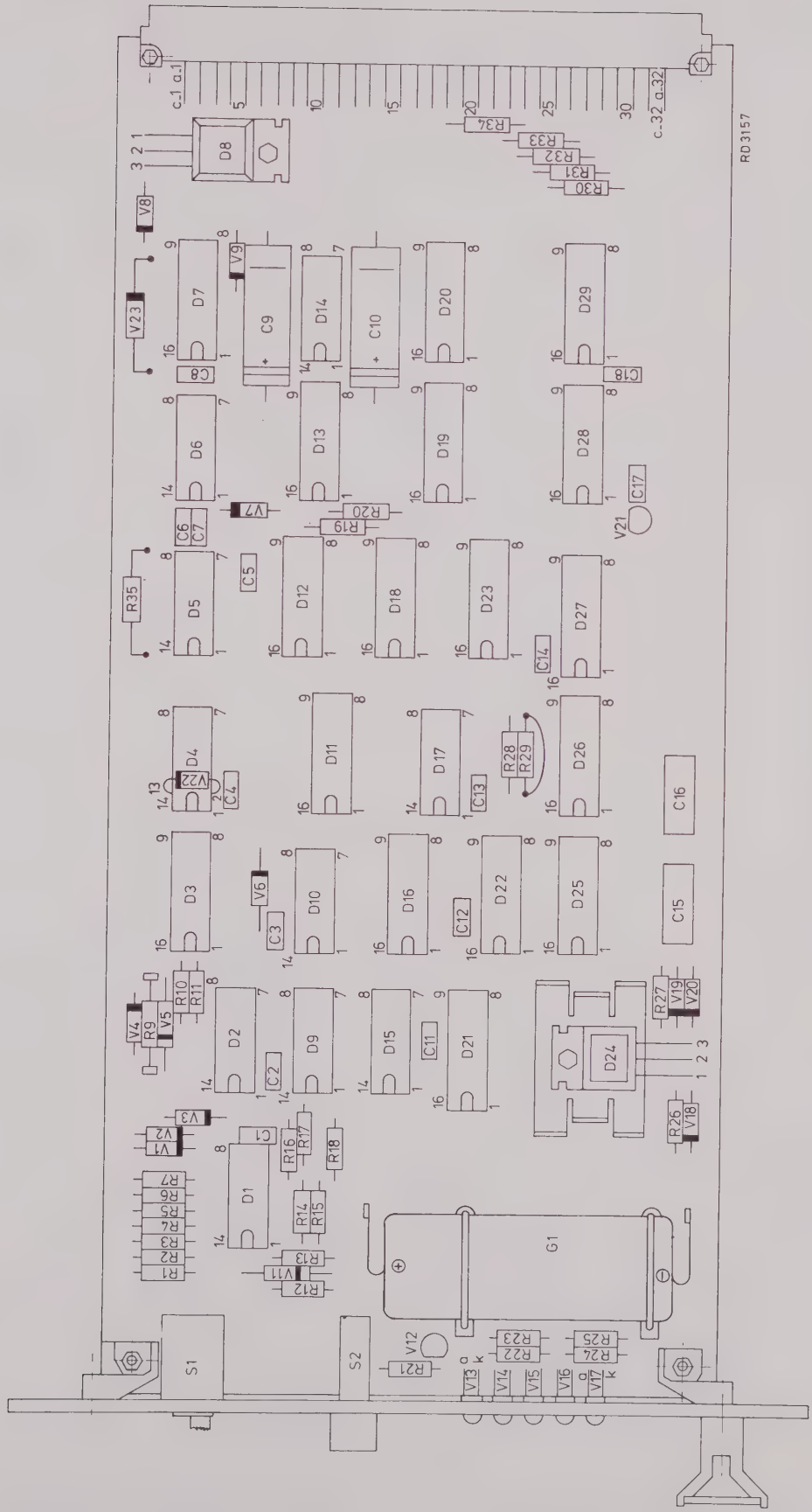


Fig. 8.1.11. Bus interface pcb

8.1.12. CPU/ROM pcb A16 (1st version)

Factory code 4022 332 82290

Ordering code 5322 694 14363

Item	*Description*			*Ordering code*
Capacitors				
C1, 2	56 pF	2 %	100 V	4822 122 31074
C3	15 µF	10 %	20 V	5322 124 10017
C4, 5, 6	33 µF	10 %	10 V	5322 124 10091
Integrated circuits				
D1	PROM 2716 INDICATION 3			5322 694 14484
D2	PROM 2716 INDICATION 2			5322 694 14485
D3	PROM 2716 INDICATION 1			5322 694 14486
D4	PROM 2716 INDICATION 0			5322 694 14487
D5	PROM 2716 INDICATION 7			5322 694 14488
D6	PROM 2716 INDICATION 6			5322 694 14489
D7	PROM 2716 INDICATION 5			5322 694 14491
D8	PROM 2716 INDICATION 4			5322 694 14492
D9	HEF4556BP			4822 209 10004
D10	8080 A Microprocessor			5322 209 85845
D11	op amp. TCA325A			5322 209 85835
D12	HEF4001BP			5322 209 14045
D13	HEF4013BP			5322 209 10002
D14, 22-24	HEF40097BP			5322 209 14433
D15	HEF4027BP			5322 209 14055
D16	HEF4075BP			5322 209 14067
D17	HEF4011BP			5322 209 14046
D18	HEF4069UBP			5322 209 14128
D19-21	HEF4050BP			5322 209 14068
Resistors				
R1	10 M	10 %	CR25	4822 110 63214
R2	2k74	1 %	MR25	5322 116 50636
R3	27k4	1 %	MR25	5322 116 50559
R4	22 E	1 %	MR25	5322 116 54002
R5	100 k	1 %	MR25	5322 116 54696
R6	10 k	1 %	MR25	5322 116 54619
R7	22 k	20 %	0,5 W	5322 101 14069
R8	7k5	1 %	MR25	5322 116 54608
Crystals				
CRB1	3,932160 MHz quarz			5322 242 74296
Diode				
V1	BZX75C2V8			5322 130 34048
V2	BAW62			4822 130 30613

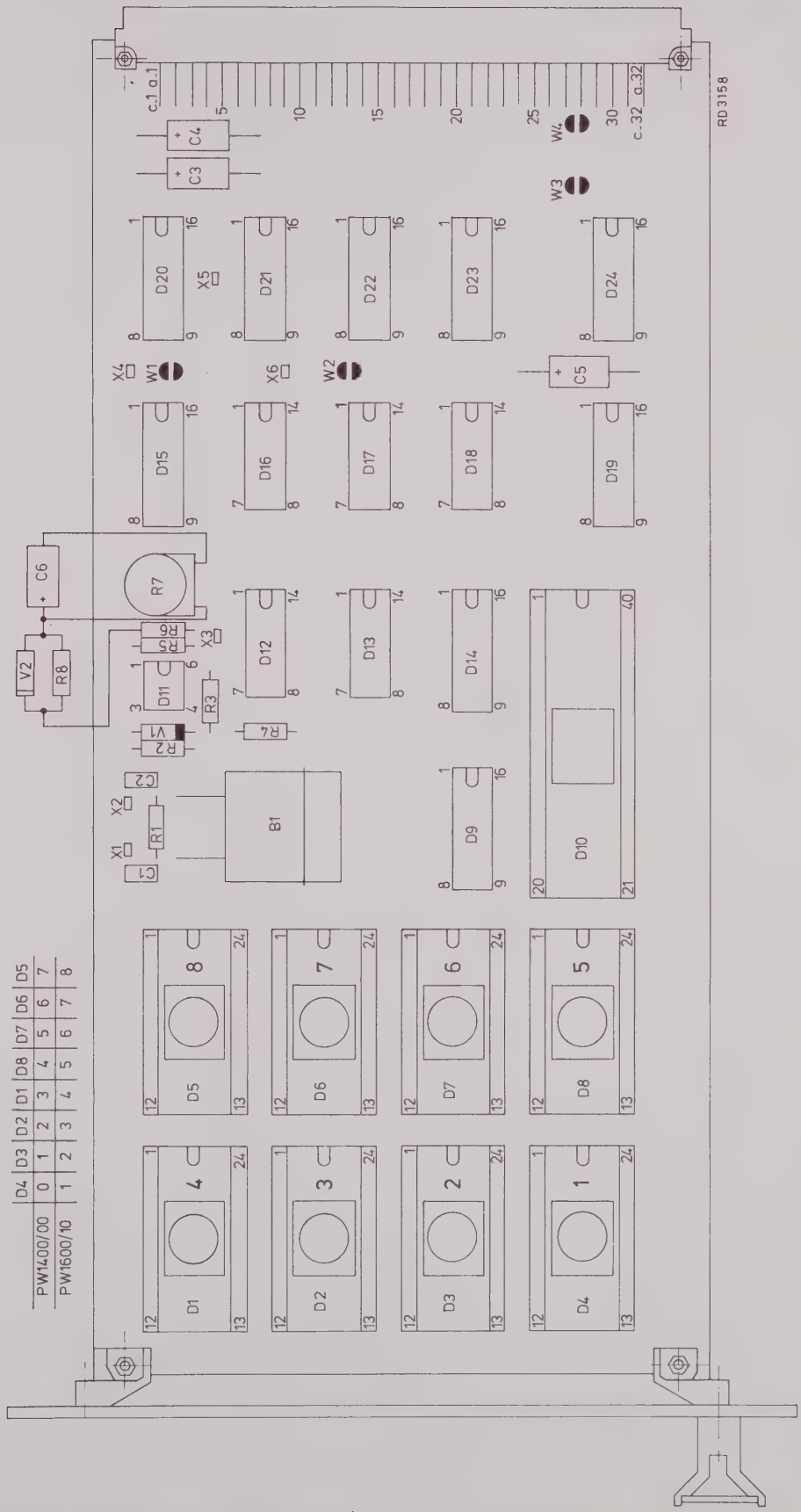


Fig. 8.1.12a CPU/ROM pcb (1st version)

8.1.12. CPU/ROM pcb A16 (2nd version)

Factory code 4022 332 82290 — Ordering code 5322 694 14363

Item	*Description*			*Ordering code*
Capacitors				
C1, 4	33 µF	10 %	10V	
C2, 8, 11	2,2 µF	10 %	20V	
C3	15 µF	10 %	10V	5322 124 10017
C5, 6, 7	22 µF			
C9, 10	5,6 pF			4822 122 31074
Integrated circuits				
D1	PROM 2716 INDICATION 3			5322 694 14484
D2	PROM 2716 INDICATION 2			5322 694 14485
D3	PROM 2716 INDICATION 1			5322 694 14486
D4	PROM 2716 INDICATION 0			5322 694 14487
D5	PROM 2716 INDICATION 7			5322 694 14488
D6	PROM 2716 INDICATION 6			5322 694 14489
D7	PROM 2716 INDICATION 5			5322 694 14491
D8	PROM 2716 INDICATION 4			5322 694 14492
D9	P8080A microprocessor chip			5322 209 85845
D10, 12, 15	HEF4019BP			
D11	HEF4556BP			4822 209 10004
D13	HEF4001BP			5322 209 14045
D14, 21, 22, 23	HEF40097BP			5322 209 14433
D16, 24, 25	HEF4050BP			5322 209 14068
D17	HEF4069UBP			5322 209 14128
D18	HEF4093BP			5322 209 14186
D19	HEF4075BP			5322 209 14067
D20	HEF4013BP			5322 209 10002
D26	HEF4516BP			

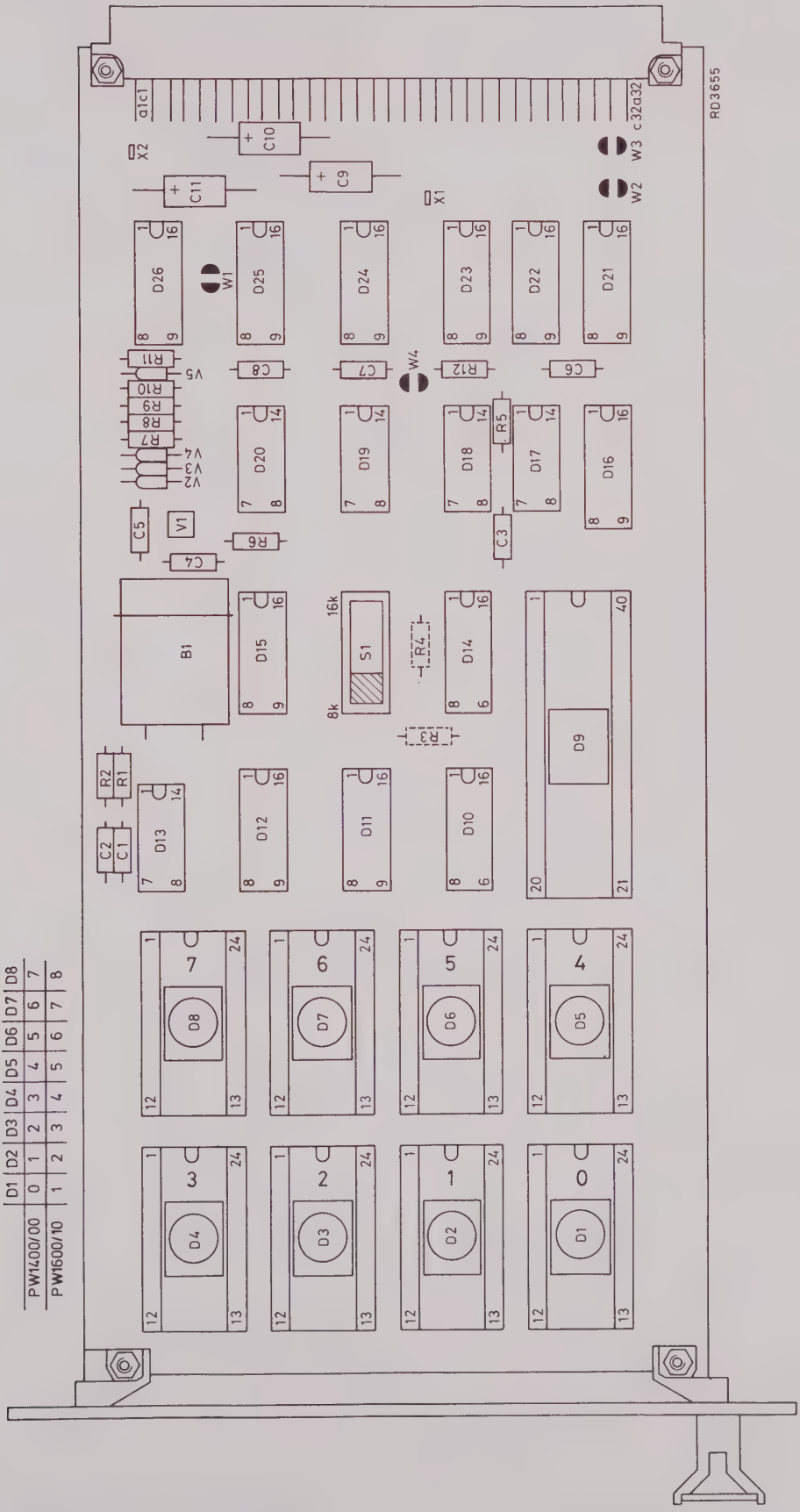


Fig. 8.1.12.b CPU/ROM pcb (2nd version)

8.1.13. Random access memory pcb A17

Factory code 4022 332 82280

Ordering code 5322 694 14364

Item	*Description*			*Ordering code*
Capacitors				
C1	33 μF	10 %	10 V	5322 124 10091
Integrated circuits				
D1-16	MCM51L01P45			5322 209 10155
D17, 19, 24	HEF4050BP			5322 209 14068
D18, 21	HEF4073BP			5322 209 14066
D20, 25	HEF40097BP			5322 209 14433
D22	HEF4011BP			5322 209 14046
D23	HEF4028BP			5322 209 14056
D26	HEF4069UBP			5322 209 14128
Resistors				
R1	47k5	1 %	MR25	5322 116 54671

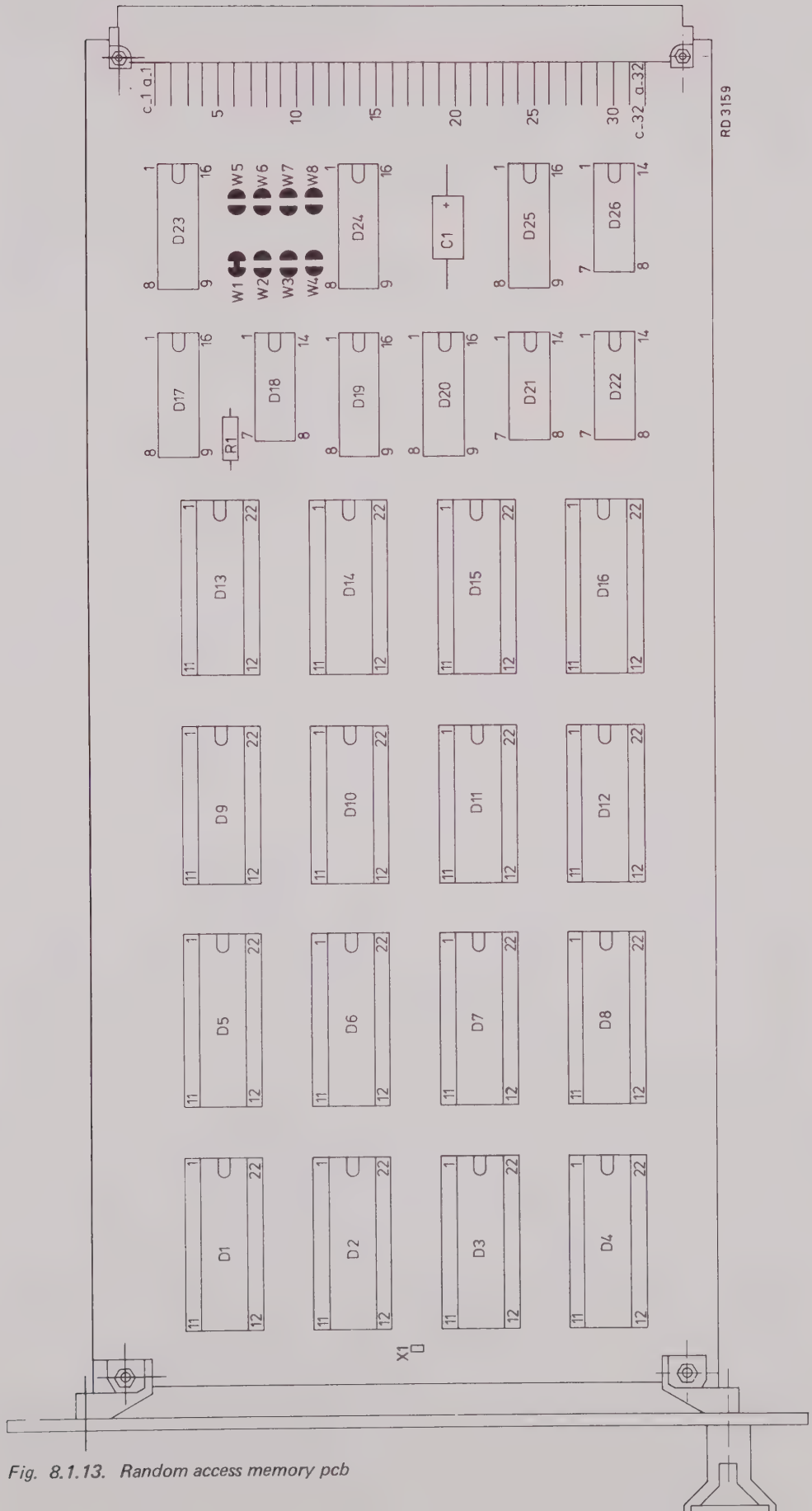


Fig. 8.1.13. Random access memory pcb

8.1.14. Serial interface pcb A19, A20

Factory 4022 332 82270 — Ordering code 5322 694 14379

Item	*Description*			*Ordering code*
Capacitors				
C101	100 pF	2 %	100 V	4822 122 31081
C102, 104, 107, 108, 110	22 nF	−20 +80 %	40 V	4822 122 30103
C103	100 µF	−10 +50 %	10 V	4822 124 20462
C105, 106	22 pF	2 %	100 V	4822 122 31063
C109, 111, 112	470 pF	2 %	100 V	4822 122 30034
Crystals, opto couplers, etc.				
B101-107	opto coupler CNY 57A			5322 209 85579
B108	Telequartz GMBH type T95100 HC-47/U			5322 242 74302
Integrated circuits				
D101	P8251			5322 209 85847
D102	4702PC			5322 209 85844
D103, 104	N8T15			5322 209 85829
D105, 106	N8T16			5322 209 85831
D107-111	HEF40097BP			5322 209 14433
D112	HEF4072BP			5322 209 14074
D113, 114	HEF4049BP			5322 209 14049
D115	HEF4050BP			5322 209 14068
D116	HEF4071BP			5322 209 14053
D117	HEF4023BP			5322 209 14065
Resistors				
R101, 111	10 k	1 %	MR25	5322 116 54619
R102, 108, 115, 116	5k6	1 %	MR25	5322 116 54011
R103, 109, 117, 118	332 E	1 %	MR25	5322 116 54513
R104	3k83	1 %	MR25	5322 116 54589
R105, 112	383 E	1 %	MR25	5322 116 54518
R106, 113	562 E	1 %	MR25	5322 116 54009
R107	2k05	1 %	MR25	5322 116 50664
R110	5E11	1 %	MR25	5322 116 54192
R114	10 M	10 %	CR25	4822 110 63214
R119, 122, 123	9k09	1 %	MR25	5322 116 54615
R120, 124, 126	154 E	1 %	MR25	5322 116 50506
R121, 125, 127	15k4	1 %	MR25	5322 116 50479
R128-140	27k4	1 %	MR25	5322 116 50559
R141-147	154 k	1 %	MR25	5322 116 54714
R148	1k05	1 %	MR25	5322 116 54552
R149	226 k	1 %	MR25	5322 116 54729
Switches				
S101-109	Switch 2 pole			5322 277 24045
S110-111	Switch 1 pole			5322 277 24053
Transistors				
V101-103	BC547			4822 130 44257

Item	*Description*		*Ordering code*
Diodes			
V104, 105	BZX79-C4V7		5322 130 34174
V106-108	BAW62		4822 130 30613
Connectors			
X101	F068-I	Board part	5322 265 64082
X102	HDP20	25 pole	5322 265 64083
General parts			
	IC socket	28 pole	5322 255 44047

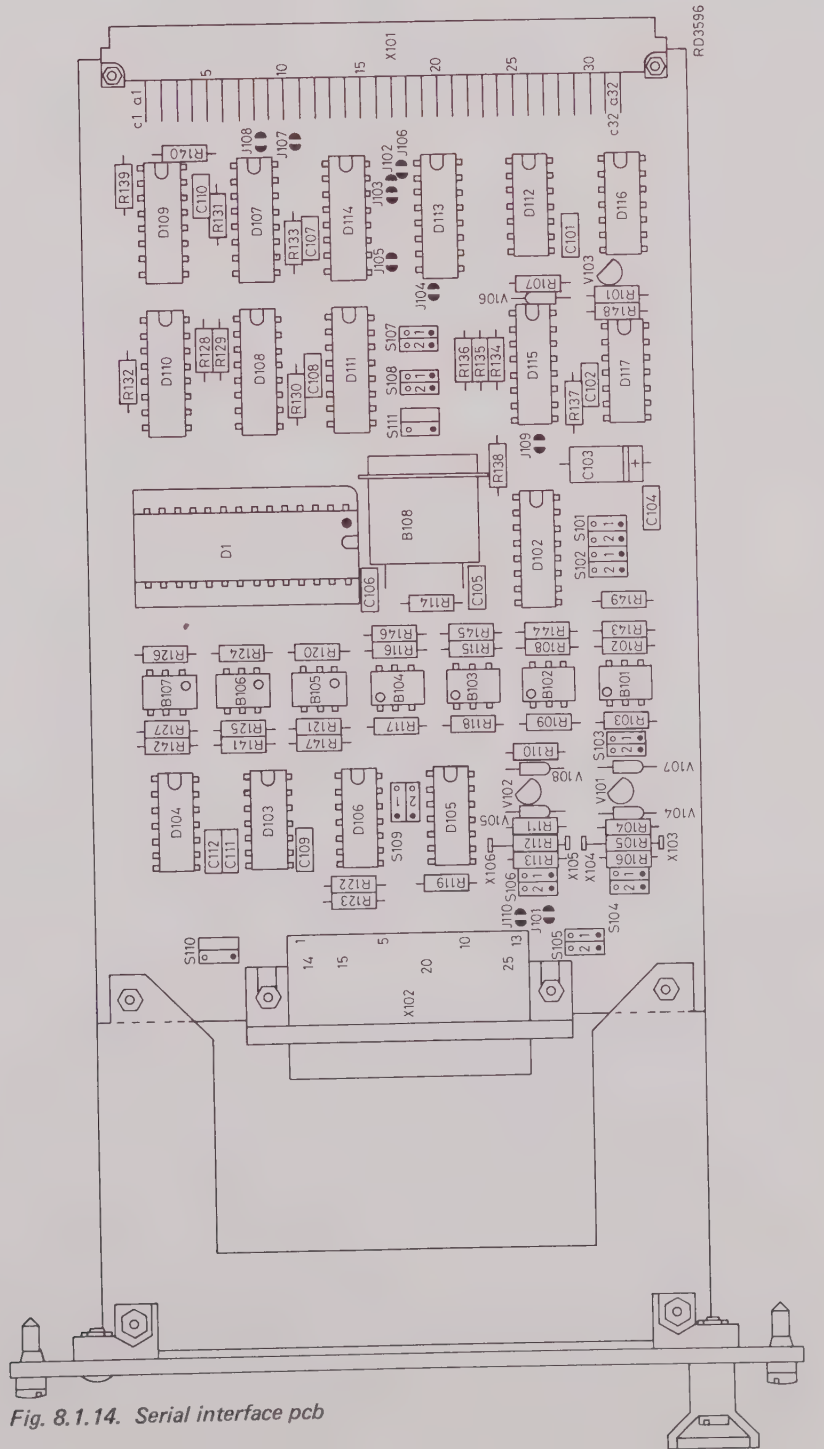


Fig. 8.1.14. Serial interface pcb

8.1.15. Coil driver pcb A31, A32

	Factory code 4022 332 82670			Ordering code 5322 694 14342
Item	*Description*			*Ordering code*
Capacitors				
C1-10	47 µF	−10 +50 %	63 V	4822 124 20501
C11	220 nF	10 %	100 V	4822 121 40232
Integrated circuits				
D1, 2	HEF40097BP			5322 209 14433
D3	HEF4049BP			5322 209 14049
Fuses				
F1-3	1 A	F 5X20		4822 253 20018
F4-10	0,5 A	F 5X20		4822 253 20014
Resistors				
R1-5,7,9,11-13,24-29,34-45	10 k	1 %	MR25	5322 116 54619
R30, 31, 46-49	1 k	1 %	MR25	5322 116 54549
R20-22	68E1	1 %	4,2 W	5322 116 54455
R23, 32, 33, 50-53	100 E	1 %	MR25	5322 116 54469
R6, 8, 10	2k05	1 %	MR25	5322 116 50664
Transistors				
V1-3	BD645			4822 130 41211
V7-13	BSS51			5322 130 44451
Diodes				
V14	BY227			4822 130 34633

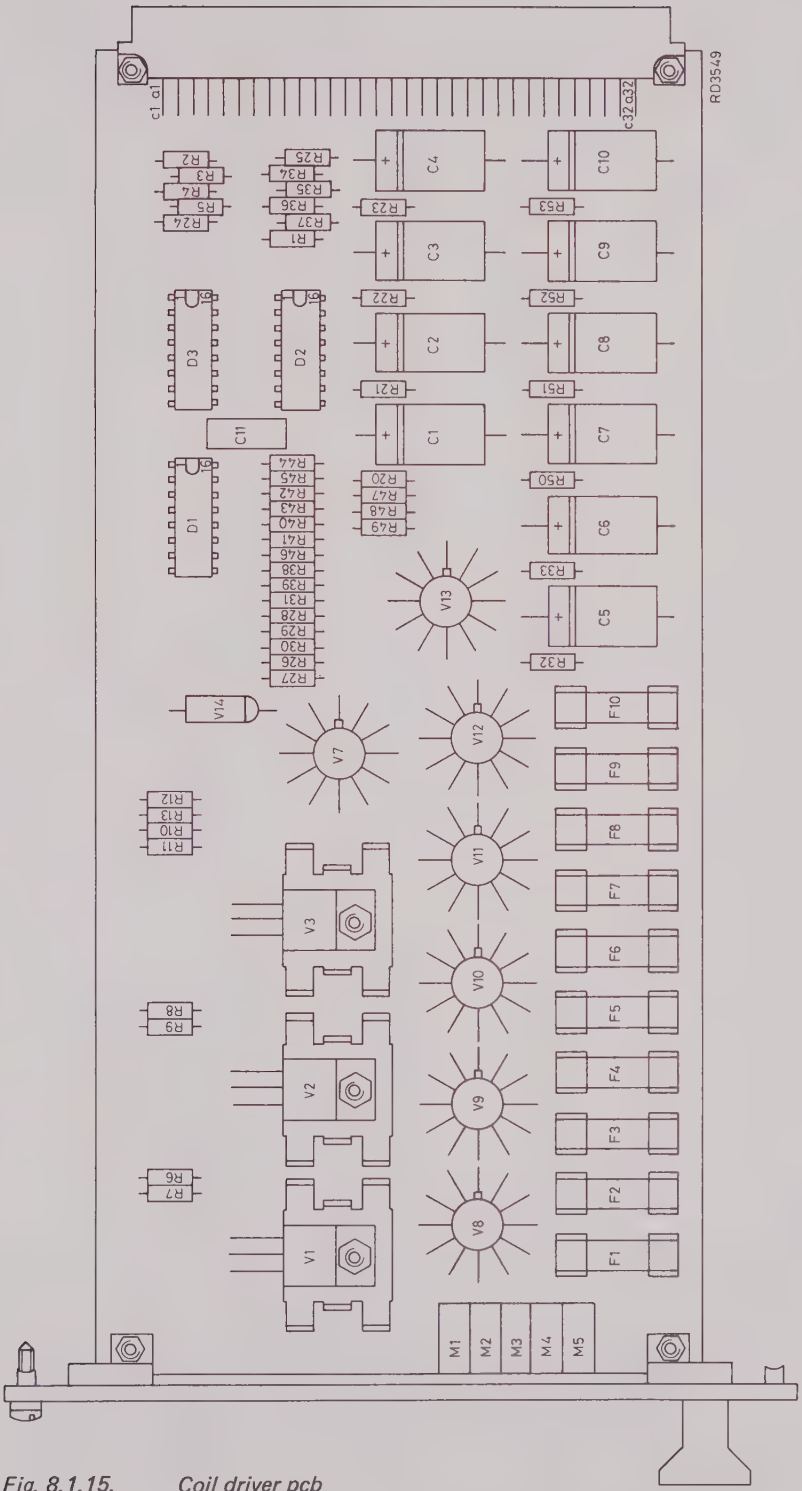


Fig. 8.1.15. *Coil driver pcb*

8.1.16. Power supply pcb A34

Item	Description			Factory code 4022 332 8256 / Ordering code 5322 694 14343 Ordering code
Capacitors				
C1	10000 µF	−10 +50 %	40 V	5322 124 74098
C2	4700 µF	−10 +50 %	40 V	4822 124 70173
C3, 4	680 µF	−10 +50 %	40 V	4822 124 20534
C5, 6	15 µF	−20 +20 %	10 V	5322 124 10017
C7-12	22 nF	−20 +80 %	40 V	4822 122 30103
Integrated circuits				
D1, 2	7824CU			5322 209 85833
D3	7812CU			5322 209 85603
Resistors				
R1, 2	1 E	5 %	CR25	4822 110 63027
R3	15 E	5 %	CR25	4822 112 41058
R4, 5	100 E	5 %	CR25	4822 112 41081
Diodes				
V1-4	BYX71-600			4822 130 34522
V5-8, 10	BY164			4822 130 30414
V9	BZX75-C2V1			4822 130 34049

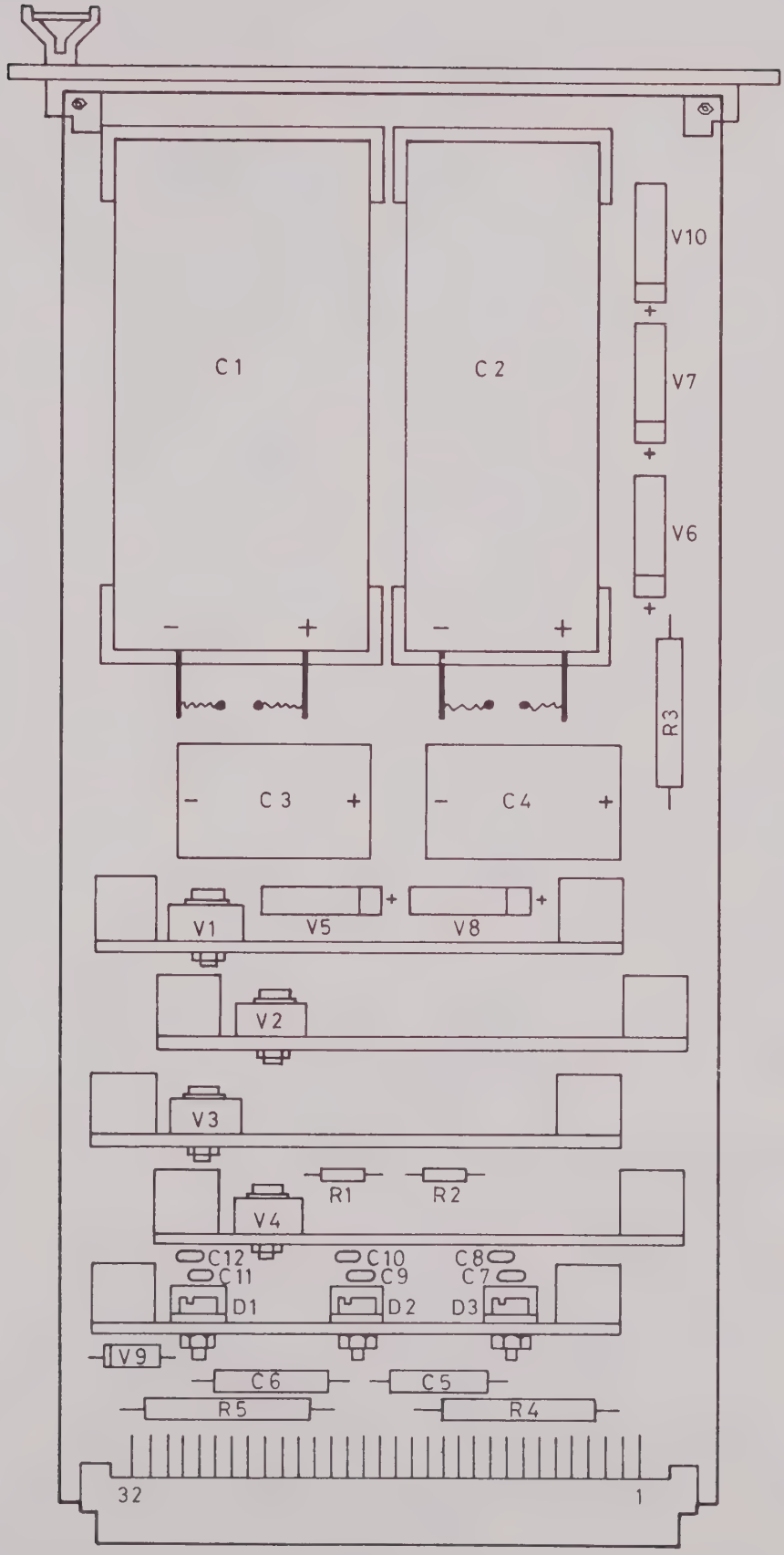


Fig. 8.1.16. *Power supply pcb* RD 3136

8.1.17. Motor drive pcb A36

	Factory code 4022 332 82550			Ordering code 5322 694 14366
Item	*Description*			*Ordering code*
Capacitors				
C1	680 µF	−10 +50 %	40 V	4822 124 20534
C2, 3, 5, 6, 8, 9	6,8 µF	10 %	100 V	4822 121 40252
C4, 7, 10	4,7 µF	10 %	100 V	5322 121 40224
C11	100 nF	10 %	100 V	5322 121 40323
Integrated circuits				
D1	HEF4017BP			5322 209 14444
D2-7	CNY42			5322 209 84522
Resistors				
R1-6, 13-24, 27, 28	10 k	5 %	CR25	4822 110 63134
R7-12	100 k	5 %	CR25	4822 110 63161
R25	8E2	5 %	4,2 W	4822 112 21052
R26	620 E	5 %	CR25	5322 116 55028
R29	1 k	5 %	CR25	4822 110 43107
R30-32	15 E	5 %	7 W	4822 112 41058
R33-38	1 mA	20 %	56 V	4822 116 20101
R39-44	270 E	5 %	CR37	4822 110 53092
R45	470 k	5 %	CR25	4822 110 63178
Transistors				
V1-6	BC547			4822 130 44257
V7, 8	BC557			4822 130 44256
V9	BD138			4822 130 40665
Diodes				
V10	BY206			4822 130 30839
V11	BZX79-C12			4822 130 34197
V12, 13, 20	BAX12A			5322 130 34605
V14-19	BT139-600	TRIAC		5322 130 24079
Fuses				
F1-6	1 A	T 5X20		4822 253 30021

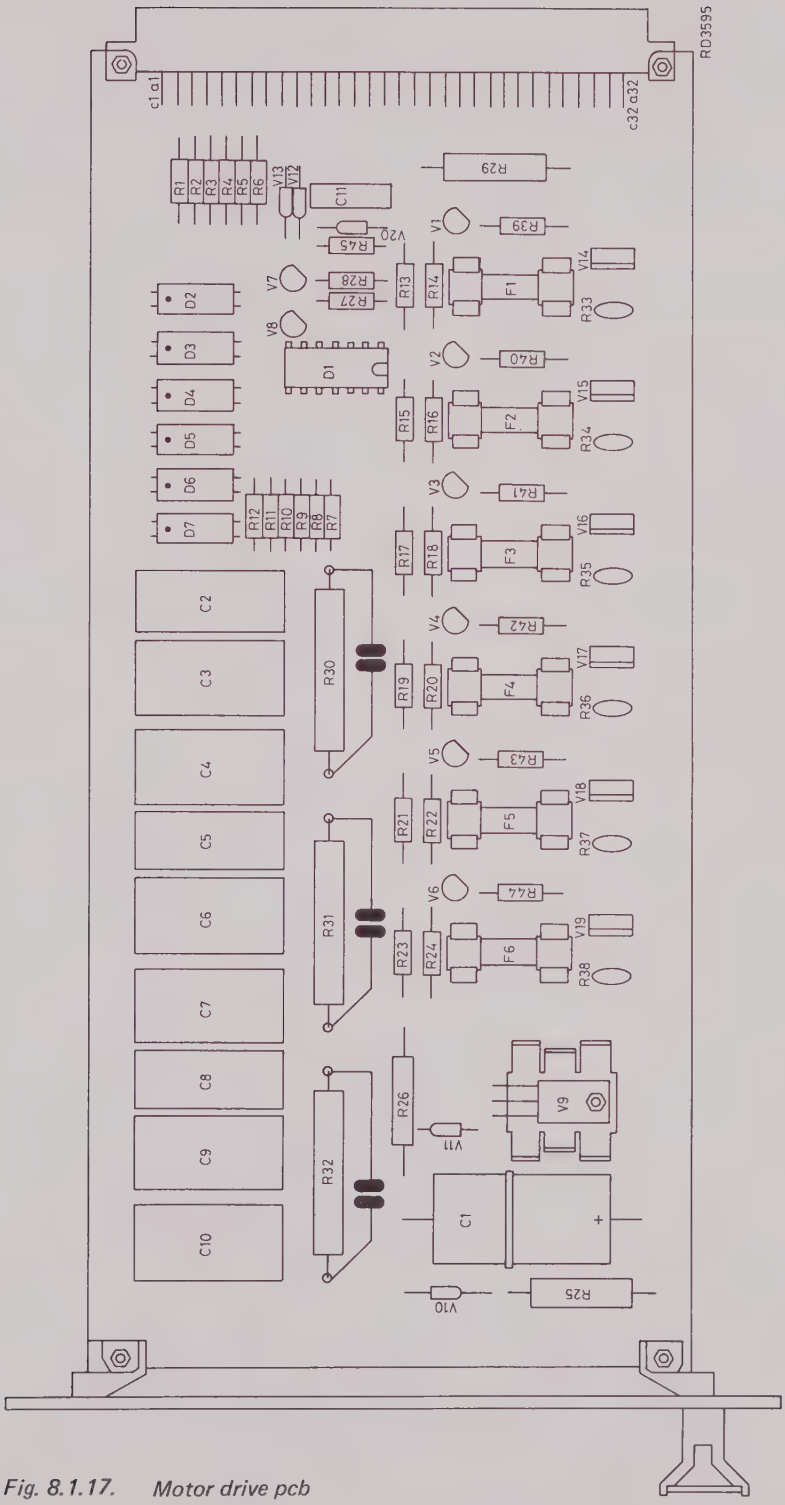


Fig. 8.1.17. Motor drive pcb

8.1.18. Stepping motor supply/driver pcb A37

	Factory code 4022 332 82530			Ordering code 5322 694 14365
Item	*Description*			*Ordering code*
Capacitors				
C5	220 µF	−10 +50 %	63 V	4822 124 20537
C7-9	680 µF	−10 +50 %	40 V	4822 124 20534
C10-15	2200 µF	−10 +50 %	10 V	4822 124 20521
Fuses				
F1	3,15 A	F 5X20		4822 253 20025
Resistors				
R1-5	10 k	5 %	CR25	4822 110 63134
R6-10, 23	5k6	5 %	CR25	4822 110 63127
R11-14	39 E	5 %	CR25	4822 110 53069
R15-18	1 k	5 %	CR25	4822 110 63107
R19, 20	270 E	5 %	4,2 W	4822 112 21092
R21, 22, 24	2k2	5 %	CR25	4822 110 63116
Transistors				
V1-4	BSS51			5322 130 44451
V5	BCY59-X			5322 130 44453
V6-9	BDX78	(TO220)		5322 130 44278
V10	BCY70			5322 130 40324
V11	BDX63			5322 130 44477
Diodes				
V12-15	BY227			4822 130 34633
V16	BYX71-600			4822 130 34522
V17-20	BYX71-600R			4822 130 30866

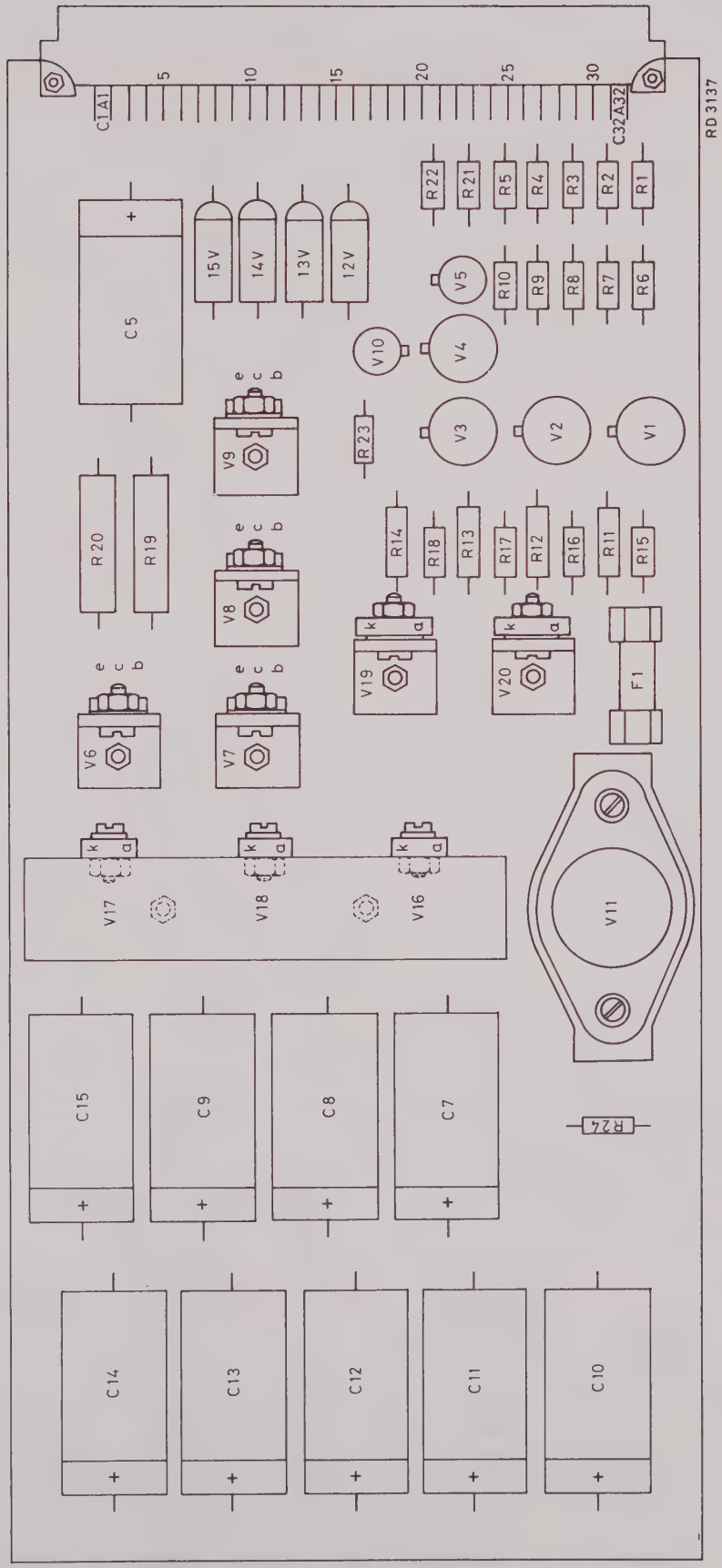


Fig. 8.1.18. Stepping motor supply / driver pcb

1.1.19. Miscellaneous control pcb A38

Item	Factory code 4022 332 82580 Description			Ordering code 5322 694 14344 Ordering code
Capacitors				
C1, 2, 5, 6, 7, 13, 14, 18	220 nF	10 %	100 V	4822 121 40232
C3, 4	4,7 nF	−20 +80 %	40 V	4822 122 31125
C8, 9, 15	470 nF	10 %	100 V	5322 121 40175
C10, 16, 17	47 µF	−10 +50 %	63 V	4822 124 20501
C11, 12, 19-24	22 nF	−20 +80 %	40 V	4822 122 30103
Integrated circuits				
D1, 2, 3, 5, 7	LM324N			5322 209 85582
D4, 6, 8	HEF4093BP			5322 209 14186
Fuses				
F1	0, 5 A	F 5X20		4822 253 20014
F2, 3	1 A	F 5X20		4822 253 20018
Resistors				
R1, 5, 13, 14, 29, 32, 37, 42, 51, 53, 94	4k87	1 %	MR25	5322 116 50509
R2, 6	825 E	1 %	MR25	5322 116 54541
R3, 7, 18, 24, 26, 28, 31, 34, 35, 36, 40, 43, 44, 47, 49, 50, 52, 55, 56, 65-68, 71, 72, 78, 80, 81, 86, 87, 89,-92, 95, 98-100, 101	10 k	1 %	MR25	5322 116 54619
R4, 8, 19	30k1	1 %	MR25	5322 116 54655
R9	40k2	1 %	MR25	5322 116 54665
R11, 23	20 k	10 %	1 W	5322 103 14065
R12, 22	24k3	1 %	MR25	5322 116 54647
R16	100 k	10 %	60MW	5322 116 30029
R17	50 k	10 %	1 W	5322 103 14058
R20, 21, 54	100 k	1 %	MR25	5322 116 54696
R25	470 k	5 %	CR25	4822 110 63178
R27, 61, 62, 74, 75, 10, 82, 85, 97	1 k	1 %	MR25	5322 116 54549
R33, 38, 58, 59	2k05	1 %	MR25	5322 116 50664
R41, 63	10 k	10 %	1 W	5322 103 10023
R45	2M2	10 %	CR25	4822 110 63196
R46	10 M	10 %	CR25	4822 110 63214
R48	48k7	1 %	MR25	5322 116 50442
R57, 15	10 E	1 %	MR25	5322 116 50452
R60	7k15	1 %	MR25	5322 116 54606
R64	154k	5 %	CR25	4822 110 54714
R69, 77	12k1	1 %	MR25	5322 116 50572
R70, 79	18k7	1 %	MR25	5322 116 50558
R76, 83	68E1	1 %	MR25	5322 116 54455
R88	1 M	5 %	CR25	4822 110 63187
R93	1k69	1 %	MR25	5322 116 54567
R96	100 E	1 %	MR25	5322 116 54469
R30	7k87	1 %	MR25	5322 116 50458

Item	*Description*	*Ordering code*
Transistors		
V1	BCY87	5322 130 40423
V2	BSV80	5322 130 34044
V3-5	BSS51	5322 130 44451
V6, 7	BD645	4822 130 41211
Diodes		
V8, 10	BAV21	4822 130 30842
V9	CQY95	4822 130 30923
V11-14		
Sockets		
X 1,2	Socket	5322 267 34074

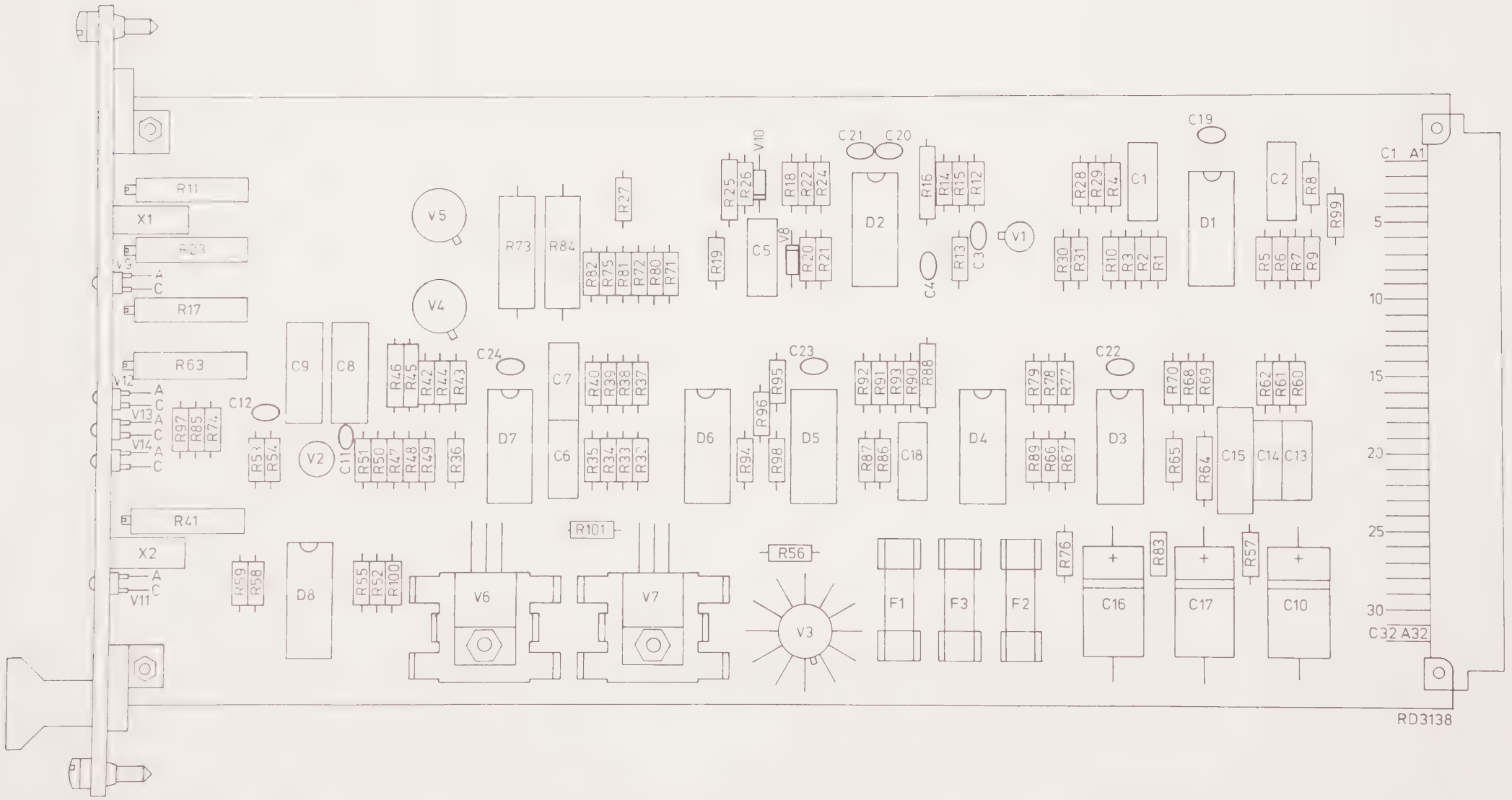


Fig. 8.1.19. Miscellaneous control pcb

8.1.20. Generator control & safety pcb A39

Factory code 4022 332 82590

Ordering code 5322 694 14345

Item	*Description*			*Ordering code*
Capacitors				
C2-4	10 µ F	−10 +50 %	63 V	4822 124 20728
C5-8	1 µ F	10 %	100 V	5322 121 40197
Integrated circuits				
D1-14	CNY42			5322 209 84522
D15, 16	HEF4050BP			5322 209 14068
D17	HEF4069UBP			5322 209 14128
D18	HEF4018BP			5322 209 14118
Relays				
K1-3	Relay PYE 311-2C-24H			5322 280 24111
Resistors				
R20	22 k	5 %	CR25	4822 110 63143
R2, 4, 6, 8, 10, 12, 14, 15	51k1	1 %	MR25	5322 116 50672
R19, 22, 24	100 k	5 %	CR25	4822 110 63161
R17, 21, 23	100 E	5 %	CR25	4822 110 63081
R40-43	10 k	5 %	CR25	4822 110 63134
R26	470 E	5 %	CR25	4822 110 63098
R27, 28	1k2	5 %	CR25	4822 110 63109
R29-35	1 k	5 %	CR25	4822 110 63107
R36-39	56 k	5 %	CR25	4822 110 63154
R25	5k6	5 %	CR25	4822 110 63127
Transistors				
V1, 3, 5, 7, 9, 11, 13, 15, 17	BSS51			5322 130 44451
V26	BC547			4822 130 44257
Diodes				
V19-25	BAW62			4822 130 30613

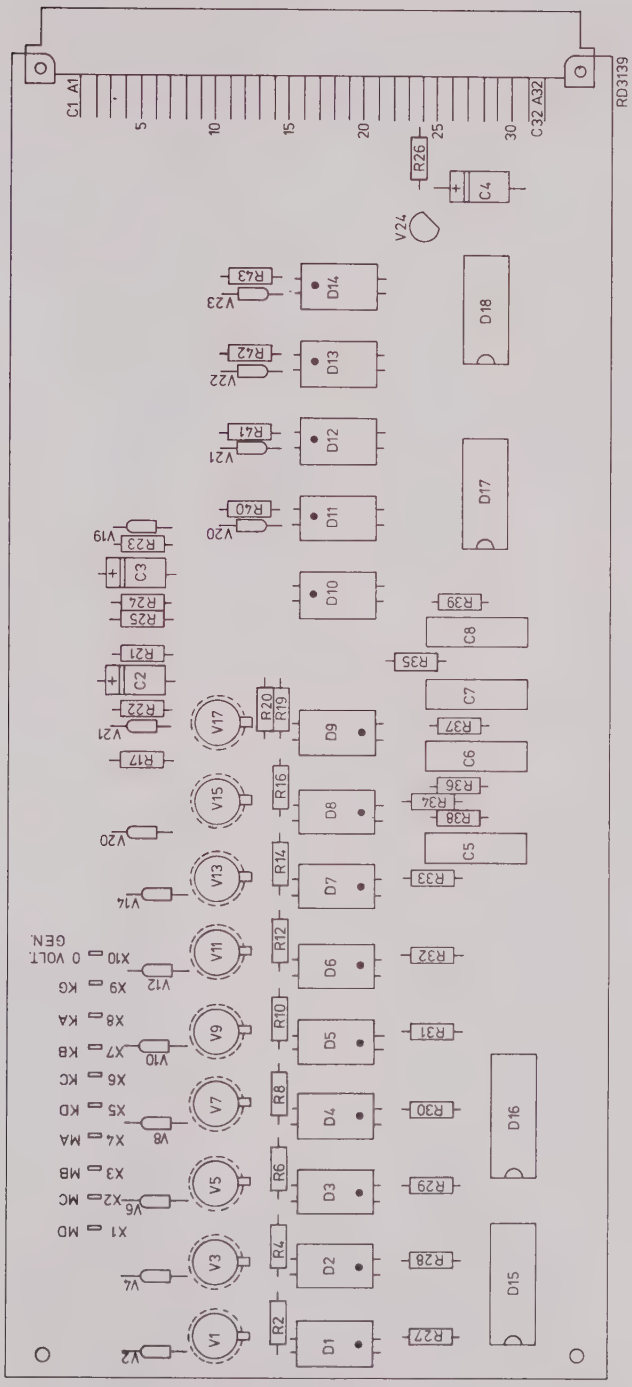


Fig. 8.1.20. Generator control and safety pcb

8.1.21. H.V. Supply, 1500 V, pcb A40

	Factory code 4022 332 82540			Ordering code 5322 694 14346
Item	*Description*			*Ordering code*
C1	3,9 nF	10 %	100 V	4822 122 30098
C2	100 nF	10 %	100 V	5322 121 40323
C3, 4, 25, 26	220 nF	10 %	100 V	4822 121 40232
C5, 24	22 nF	−20 +80 %	40 V	4822 122 30103
C6, 16, 28	10 µF	−20 +20 %	16 V	5322 124 24089
C7	68 nF	10 %	1000 V	4822 121 40386
C9-11	68 nF	10 %	1600 V	4822 121 40179
C13	100 pF	2 %	100 V	4822 122 31081
C14	2,2 nF	−20 +80 %	40 V	4822 122 31116
C15, 17, 22, 23	10 nF	−20 +80 %	40 V	4822 122 30043
C18	22 nF	−20 +80 %	40 V	4822 122 30103
C19, 27	1 nF	−20 +80 %	40 V	4822 122 30027
C20	470 nF	10 %	100 V	5322 121 40175
C21	47 nF	10 %	100 V	5322 121 44138
Integrated circuits				
D1	NE555N			5322 209 85824
D2	HEF4017BP			5322 209 14048
D3, 4	LM208T			5322 209 85475
Resistors				
R1, 9	1 k	1 %	MR25	5322 116 54549
R2	2k2	20 %	0,05 W	4822 100 10029
R3	909 E	1 %	MR25	5322 116 54545
R4, 5, 7, 22	100 E	1 %	MR25	5322 116 54469
R6, 8	402 E	1 %	MR25	5322 116 54519
R10	1 E	5 %	CR25	4822 110 63027
R12	15 k	5 %	CR37	4822 110 53138
R13	820 E	5 %	4,2 W	4822 112 21105
R15	70 M	1 %	2 W	5322 116 54998
R16	348 k	0,5 %	MR34E	5322 116 55181
R17, 19	174 k	1 %	MR25	5322 117 54719
R18, 41	10 E	1 %	MR25	5322 116 50452
R20, 35, 36, 42	10 k	1 %	MR25	5322 116 54619
R21	226 E	1 %	MR25	5322 116 54497
R23	1 k	20 %	0,05 W	4822 100 10037
R24	15 M	5 %	VR37	4822 110 42218
R25	46k4	1 %	MR25	5322 116 50557
R26	100 k	20 %	0,05 W	4822 100 10052
R27, 29	100 k	1 %	MR25	5322 116 54696
R28, 30	1 M	1 %	MR20	5322 116 54188
R31	48k7	1 %	MR25	5322 116 50442
R32	10 k	0,5 %	MR24E	5322 116 50748
R33	32k4	0,5 %	MR24E	5322 116 55259
R34	1 k	0,5 %	MR24E	5322 116 50747
R38	3k65	0,5 %	MR24E	5322 116 54221
R39	12k4	0,1 %	MR24E	5322 116 55182
R40	499 E	1 %	MR25	5322 116 54524
R37	4k99	0,5 %	MR24E	5322 116 54057

Item	*Description*	*Ordering code*
Transistors		
V1, 3, 8, 10	BC547	4822 130 44257
V2, 4, 9, 11	BC557	4822 130 44256
V5, 6	BSW68	5322 130 40714
V7	BD438	4822 130 40995
Diodes		
V15, 16	BY409-01	5322 130 34594
V19-21, 24	BAW62	4822 130 30613
V22	BZX75-C3V6	5322 130 30765
V23	BZX79-C10	5322 130 34297
V25	BZV13	5322 130 34301
V26	BZX79-C5V6	5322 130 34173
Lamp		
LA1	Neonlamp GL2	4822 134 20128
Transformer		
T1	Transformer	5322 146 14152

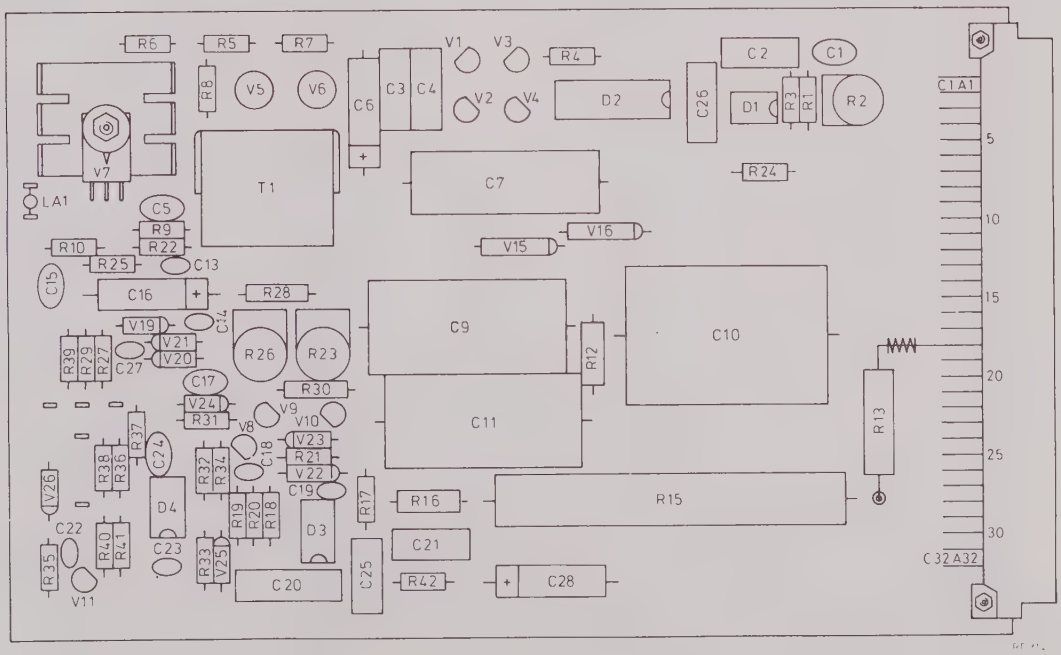


Fig. 8.1.21. HV Supply 1500 V pcb

8.1.22. H.V. supply, 3000 V, pcb A41

	Factory code 4022 332 82520			Ordering code 5322 694 14347
Item	*Description*			*Ordering code*
Capacitors				
C1	3,9 nF	10 %	100 V	4822 122 30098
C2	100 nF	10 %	100 V	5322 121 40323
C3, 4, 25, 26	220 nF	10 %	100 V	4822 121 40232
C5, 24, 18	22 nF	−20 +80 %	40 V	4822 122 30103
C6, 16, 28	10 µF	−20 +80 %	16 V	5322 124 24089
C7	68 nF	10 %	1000 V	4822 121 40386
C8, 10	33 nF	10 %	1600 V	4822 121 40195
C9, 11, 12	68 nF	10 %	1600 V	4822 121 40179
C13	100 pF	2 %	100 V	4822 122 31081
C14	2,2 nF	−20 +80 %	40 V	4822 122 31116
C15, 17, 22, 23	10 nF	−20 +80 %	40 V	4822 122 30043
C19, 27	1 nF	−20 +80 %	40 V	4822 122 30027
C20	470 nF	10 %	100 V	5322 121 40175
C21	47 nF	10 %	100 V	5322 121 44138
Integrated circuits				
D1	NE555N			4822 209 80287
D2	HEF4017BP			5322 209 14048
D3, 4	LM208T			5322 209 85475
Resistors				
R1, 9	1 k	1 %	MR25	5322 116 54549
R2, 23	2k2	20 %	0,05 W	4822 100 10029
R3	909 E	1 %	MR25	5322 116 54545
R4, 5, 7	100 E	1 %	MR25	5322 116 54469
R6, 8	402 E	1 %	MR25	5322 116 54519
R10	1 E	5 %	CR25	4822 110 63027
R11	15 M	5 %	VR37	4822 110 42218
R12	150 k	5 %	CR37	4822 110 53165
R13	1k5	5 %	4,2 W	4822 112 21112
R15	70 M	1 %	2 W	5322 116 54998
R16	174 k	0,5 %	MR34E	5322 116 55144
R17, 19	174 k	1 %	MR25	5322 116 54719
R18, 41	10 E	1 %	MR25	5322 116 50452
R20, 35, 36, 42	10 k	1 %	MR25	5322 116 54619
R21	226 E	1 %	MR25	5322 116 54497
R22	464 E	1 %	MR25	5322 116 50536
R24	30 M	5 %	VR37	5322 116 64011
R25	46k4	1 %	MR25	5322 116 50557
R26	100 k	20 %	0,05 W	4822 100 10052
R27, 29	100 k	1 %	MR25	5322 116 54696
R28, 30	1 M	1 %	MR30	5322 116 54188
R31	48k7	1 %	MR25	5322 116 50442
R32	10 k	0,5 %	MR24E	5322 116 50748
R33	32k4	0,5 %	MR24E	5322 116 55259
R34	1 k	0,5 %	MR24E	5322 116 50747
R37	4k99	0,5 %	MR24E	5322 116 54221
R39	12k4	0,5 %	MR24E	5322 116 55182
R40	499 E	1 %	MR25	5322 116 54524
R38	3k65	0,5 %	MR24E	5322 116 54057

Transistors

V1, 3, 8, 10	BC547	4822 130 44257
V2, 4, 9, 11	BC557	4822 130 44256
V5, 6	BSW68	5322 130 44788
V7	BD438	4822 130 40995

Diodes

V15-18	BY409-01	5322 130 34594
V19-21, 24	BAW62	4822 130 30613
V22	BZX75-C3V6	5322 130 30765
V23	BZX79-C10	5322 130 34297
V25	BZV13	5322 130 34301
V26	BZX79-C5V6	5322 130 34173

Lamp

LA1	Neonlamp	GL2	4822 134 20128

Transformer

T1	Transformer	5322 146 14152

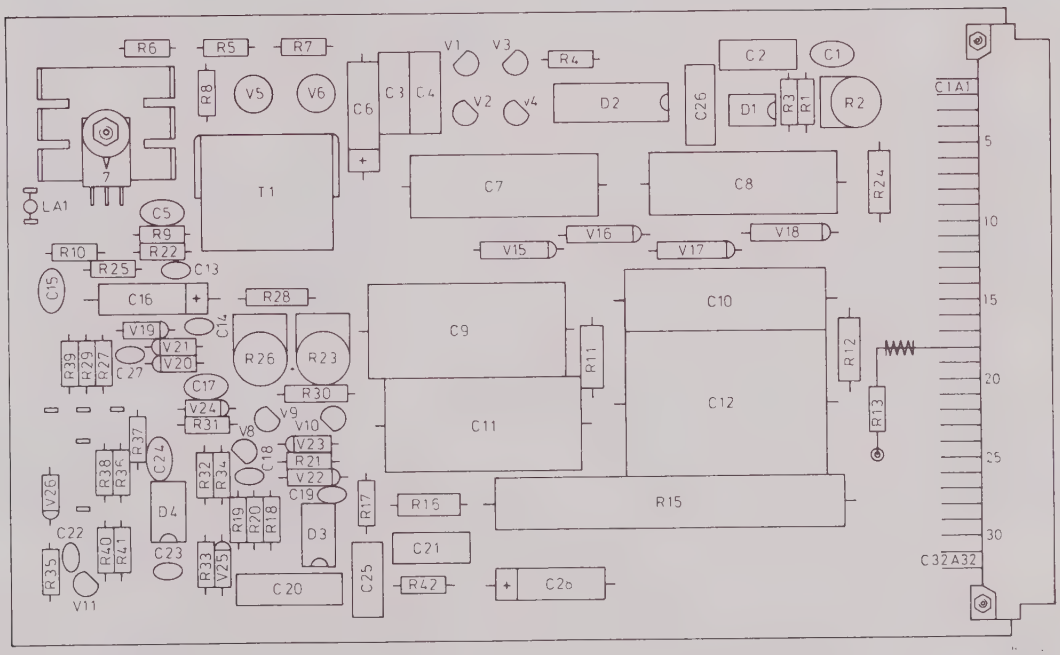


Fig. 8.1.22. HV Supply 3000 V pcb

8.1.23. Counter - Display pcb A50

	Factory code 4022 332 82510			Ordering code 5322 694 14348
Item	*Description*			*Ordering code*
Capacitors				
C1-4	100 nF	10 %	100 V	5322 121 40323
C6	680 pF	10 %	100 V	4822 122 30053
C7, 10	150 pF	2 %	100 V	4822 122 31085
C9, 8	33 µF	–20 +20 %	16 V	5322 124 24187
Integrated circuits				
D1	HEF4028BP			5322 209 14056
D2, 28	HEF4528BP			5322 209 14191
D3-5	HEF4013BP			5322 209 10002
D6-13	HEF4511BP			5322 209 14122
D14	HEF4071BP			5322 209 14053
D15-24	ULN2002NA			5322 209 85834
D25, 26	HEF4049BP			5322 209 14049
D27	HEF4081BP			5322 209 14054
Resistors				
R1-70, 85	100 E	1 %	MR25	5322 116 54469
R71, 72, 86	49k9	1 %	MR25	5322 116 50674
R73-76	10 k	1 %	MR25	5322 116 54619
R77	124 E	1 %	MR25	5322 116 54478
R78-83	162 E	1 %	MR25	5322 116 50417
R84	100 E	20 %	0,05 W	5322 101 14212
R87	953 E	1 %	MR25	5322 116 54547
Diodes				
V1-11	LED display 5082-7650			5322 130 34745
V12	CQ96			5322 130 34634
V13	BY227			4822 130 34633
V14, 15	BAW62			4822 130 30613

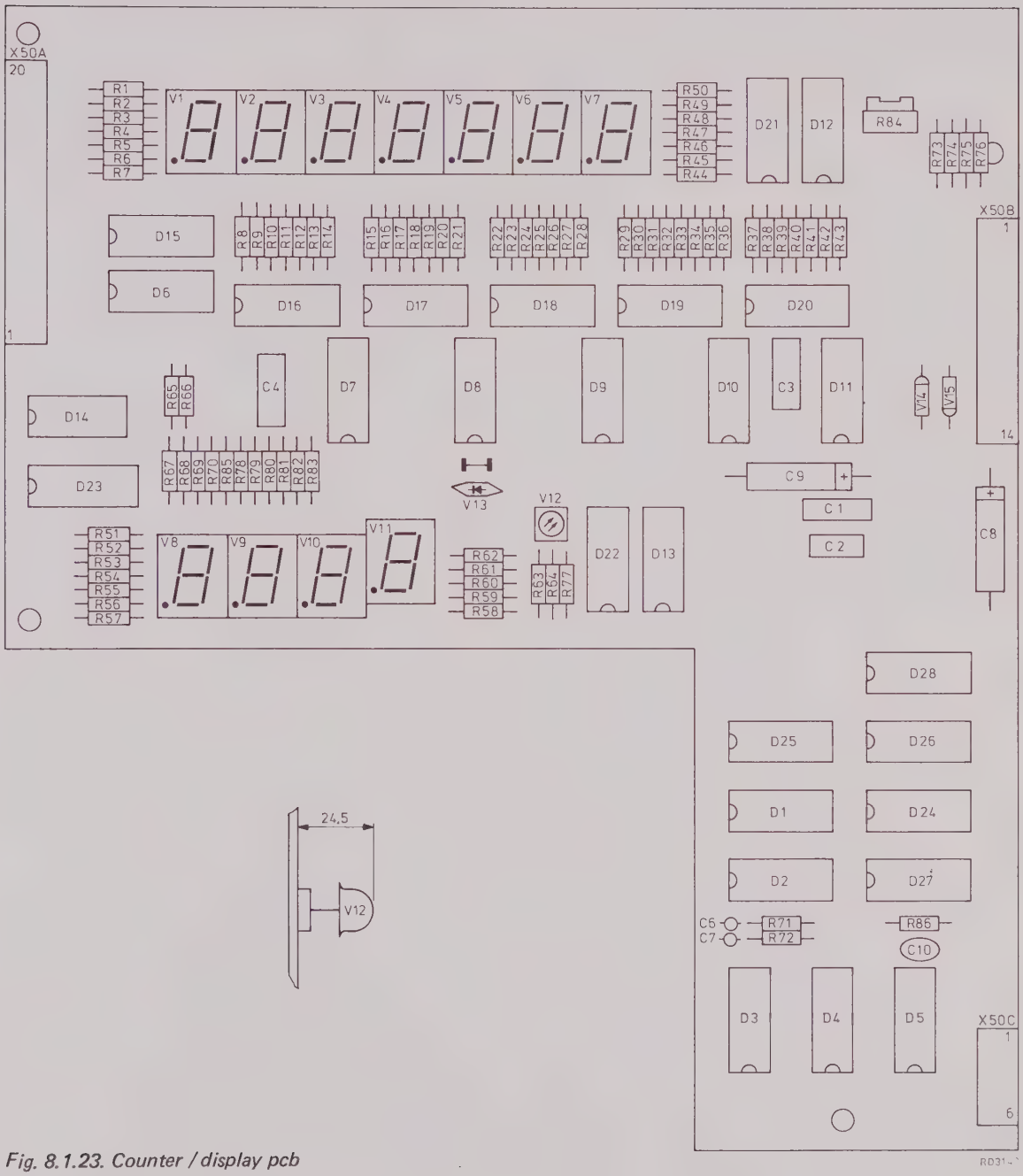


Fig. 8.1.23. Counter / display pcb

8.1.24. Upper synoptic display pcb A51

Item	Description			Factory code 4022 332 82500 / Ordering code 5322 694 14349 Ordering code
Capacitors				
C1, 2	100 nF	10 %	100 V	5322 121 40323
C3	47 µF	−20 +20 %	16 V	5322 124 24109
C4	33 µF	−20 +20 %	16 V	5322 124 24187
Integrated circuits				
D1-3	HEF4511BP			5322 209 14122
D4, 5, 7	ULN2002NA			5322 209 85834
D8	HEF4023BP			5322 209 14065
D9	HEF4075BP			5322 209 14067
D10	HEF4001BP			5322 209 14045
Resistors				
R1-26	100 E	1 %	MR25	5322 116 54469
R15-19, 27-31, 33	115 E	1 %	MR25	5322 116 54476
R32	140 E	1 %	MR25	5322 116 54484
Diodes				
V1-5, 13-16	BAW62			4822 130 30613
V6	CQY96			5322 130 34634
V7	BYX55-600			4822 130 30817
V8-12	HP7 segm. display			4022 332 31600

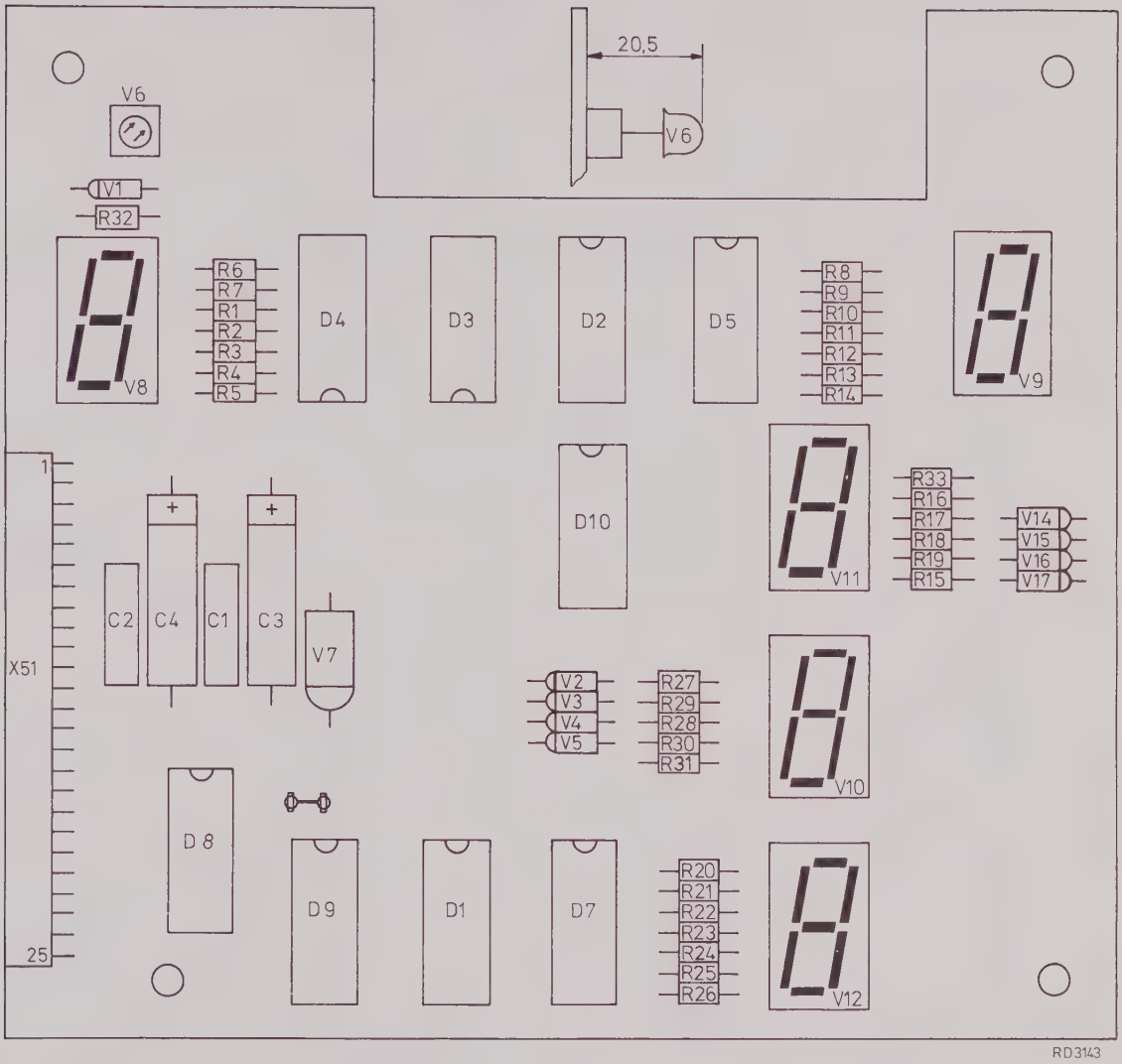


Fig. 8.1.24. Upper synoptic display pcb

8.1.25. Lower synoptic display pcb A52

	Factory code 4022 332 82490			Ordering code 5322 694 14351
Item	*Description*			*Ordering code*
Capacitors				
C1, 2	100 nF	10 %	100 V	5322 121 40323
C3, 4	68 µF	−10 +50 %	16 V	5322 124 24136
C5-8	330 pF	2 %	100 V	4822 122 30055
Integrated circuits				
D1-4	HEF4511BP			5322 209 14122
C5-7	HEF4008BP			5322 209 14214
C8-12	ULN2002NA			5322 209 85834
D13	HEF4049BP			5322 209 14049
D14	HEF4081BP			5322 209 14054
D15	HEF4071BP			5322 209 14053
D16	HEF4555BP			5322 209 14188
D17-20	HEF40175BP			5322 209 14406
Resistors				
R1-34, 45	100 E	1 %	MR25	5322 116 54469
R35-38	124 E	1 %	MR25	5322 116 54478
R39	162 E	1 %	MR25	5322 116 50417
R40	10 k	1 %	MR25	5322 116 54619
R41-44	49k9	1 %	MR25	5322 116 50674
Diodes				
V1-5	5082-7650			5322 130 34745
V6-9	CQY96			5322 130 34634
V11	BYX55-600			4822 130 30817
V12-17	BAW62			4822 130 30613
V10	BC547			4822 130 44257

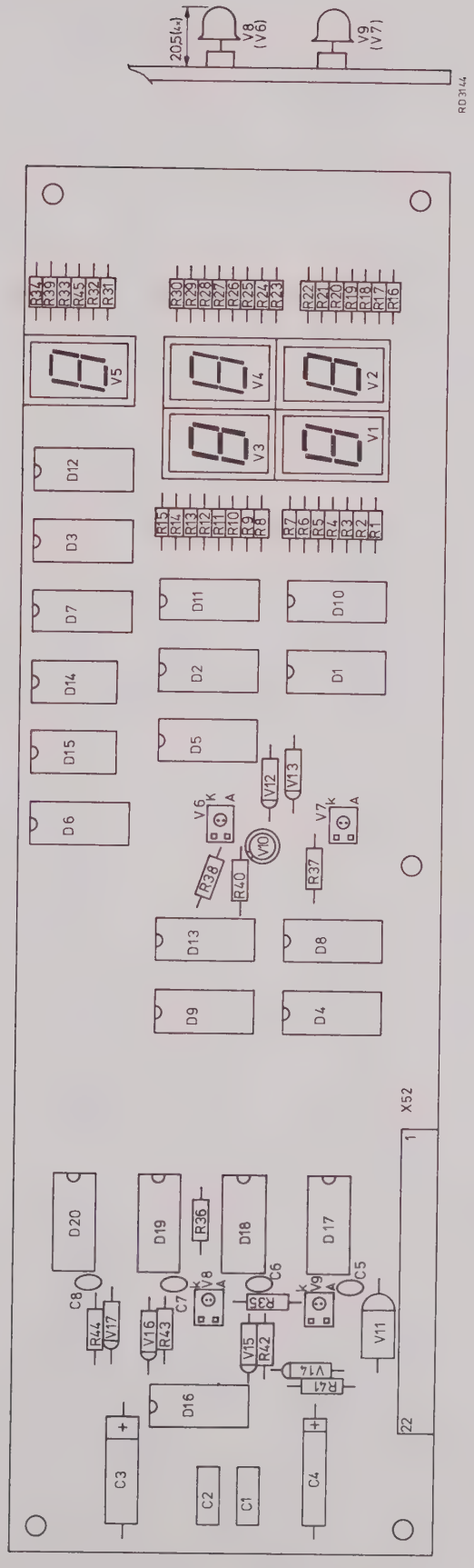


Fig. 8.1.25. Lower synoptic display pcb

8.1.26. Alphanumeric display pcb A53

	Factory code 4022 332 82480			Ordering code 5322 694 14352
Item	*Description*			*Ordering code*
Displays				
B1	D352			5322 131 94033
B2, 3	SP252			5322 130 34757
Capacitors				
C4-6	22 nF	–20 +80 %	40 V	
C1	100 pF	2 %	100 V	4822 122 31081
C2, 3	220 pF	2 %	100 V	4822 122 30094
Integrated circuits				
D1	HEF4001BP			5322 209 14045
D2	HEF4528BP			5322 209 14191
D3	HEF4520BP			5322 209 14189
D4-6	HEF40097BP			5322 209 14433
D7, 8	P2111 A-4			5322 209 85848
D9	HEF4028BP			5322 209 14056
D10, 11	P1702A	with character sets		5322 209 54588
D12, 13	D1210			5322 209 85846
D14	NE555N			5322 209 85824
Resistors				
R1	1 k	5 %	CR25	4822 110 63107
R3	4k7	5 %	CR25	4822 110 63125
R59	2k2	5 %	CR25	4822 110 63116
R52-57, 9	470 k	5 %	CR25	4822 110 63178
R61, 62	potentiometer 2k2	20 %	0,05 W	4822 100 10029
R58	100 k	5 %	CR25	4822 110 63161
R15	270 k	5 %	CR25	4822 110 63172
R6, 7, 11	390 k	5 %	CR25	4822 110 63176
R21-26, 8	3M3	10 %	CR25	4822 110 63201
R27	220 E	5 %	CR25	4822 110 63089
R28, 29, 32, 33, 36, 37, 40, 41, 44, 45, 48, 49, 60, 2	10 k	5 %	CR25	4822 110 63134
R30, 34, 38, 42, 46, 50, 20, 17	330 k	5 %	CR25	4822 110 63174
R31, 35, 39, 43, 47, 51	18 k	5 %	CR25	4822 110 63141
R4, 5	1k5	5 %	CR25	4822 110 63112
R10	1 M	5 %	CR25	4822 110 63187
R12, 16	150 k	5 %	CR25	4822 110 63165
R13, 14	220 k	5 %	CR25	4822 110 63169
R18, 19	680 k	5 %	CR25	4822 110 63183

Item	*Description*	*Ordering code*
Diodes		
V1	BZX75-C2V8	5322 130 34048
V2, 3	BZX79-C33	5322 130 34142
V4, 5	BAV21	4822 130 30842
Transistors		
V6, 8, 10, 12, 14, 16	BF422	4822 130 41084
V7, 9, 11, 13, 15, 17	BF423	4822 130 41106

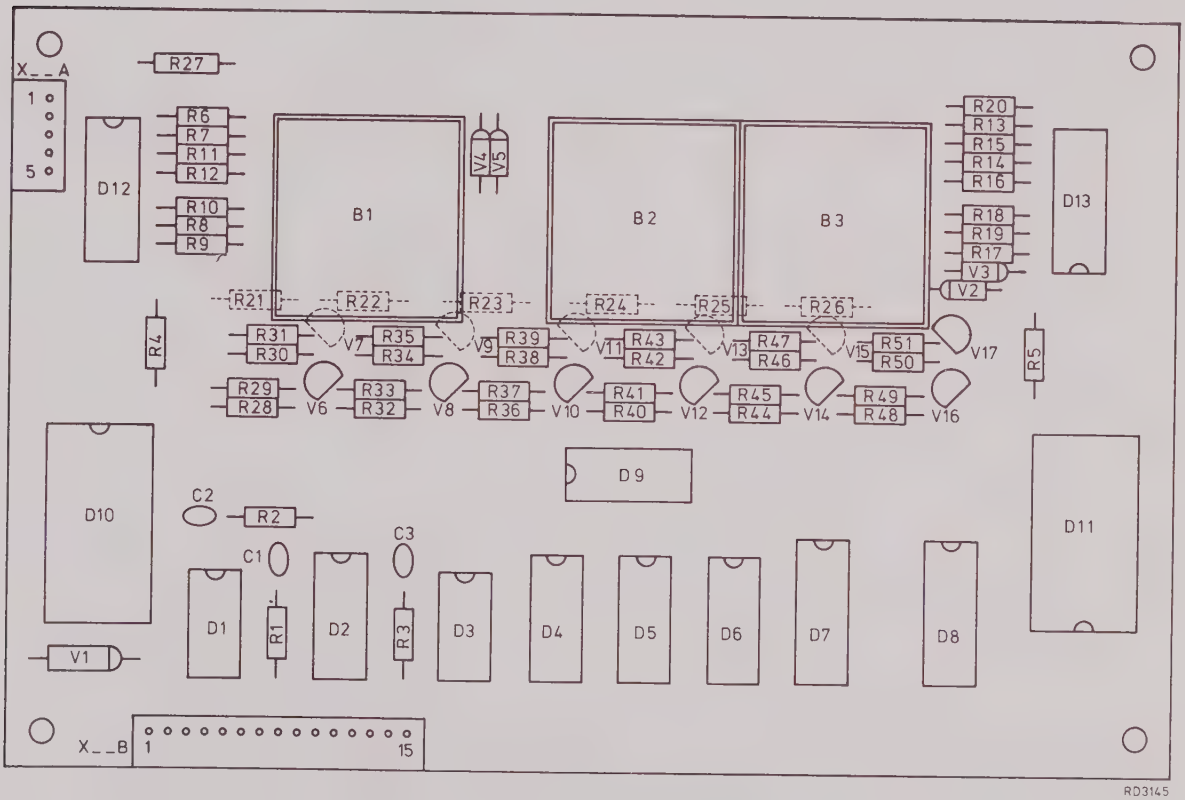


Fig. 8.1.26. Alphanumeric display pcb

8.1.27. Safety display pcb A54

	Factory code 4022 332 82470			Ordering code 5322 694 14353
Item	*Description*			*Ordering code*
Capacitors				
C1	150 µF	−10 +50 %	6,3 V	4822 124 20454
C2	68 µF	−10 +50 %	16 V	5322 124 20377
C3	22 nF	−20 +80 %	40 V	4822 122 30103
C4	150 nF	10 %	100 V	4822 121 40392
Integrated circuits				
D1	HEF4049BP			5322 209 14049
D2	HEF4073BP			5322 209 14066
D3	HEF4047BP			5322 209 14125
Resistors				
R1	150 E	5 %	CR25	4822 110 63085
R2, 3	15 k	5 %	CR25	4822 110 63138
R4	1 k	5 %	CR25	4822 110 63107
R5, 6, 12	470 E	5 %	CR25	4822 110 63098
R7, 10	10 k	5 %	CR25	4822 110 63134
R11	1 M	5 %	CR25	4822 110 63187
R8, 9	100 k	5 %	CR25	4822 110 63161
Diodes				
B1-5	LED CQY24B-111			4822 130 31144
V2, 5-7	BAW62			4822 130 30613
Transistors				
V1	BC557			4822 130 44256
V3, 4, 8	BC547			4822 130 44257

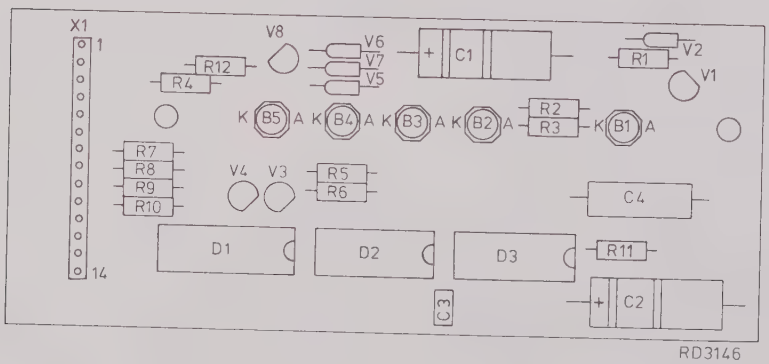
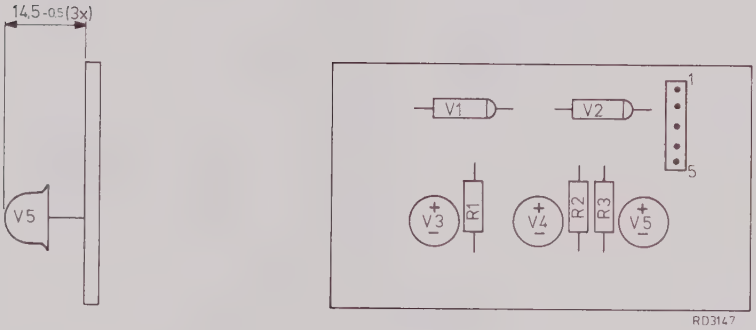


Fig. 8.1.27. Safety display pcb

8.1.28. Temperature stabilizer display pcb A55

	Factory code 4022 332 82440			Ordering code 5322 694 14354
Item	*Description*			*Ordering code*
Resistors				
R1, 2	1 k	5 %	CR25	4822 110 63107
R3	10 E	5 %	CR25	4822 110 63054
Diodes				
V1, 2	BAW62			4822 130 30613
V3-5	LED CQY96			5322 130 34634



fitted in spectrometers with serial numbers DY601-DY850

Fig. 8.1.28. Temperature stabilizer display pcb

8.1.28.1. Temperature and voltage control display pcb A55

Item	Description			Ordering code 5322 694 . . . . .
	Factory code 4022 332 83600			Ordering code
Resistors				
R1, 2, 4, 5, 6, 9, 10 11, 12, 14, 15, 16, 36-46, 57	1 k	1 %	MR25	5322 116 54549
R3	10 E	1 %	MR25	5322 116 54111
R7	2K05	1 %	MR25	5322 116 50664
R13 CERMET RST	1M8	5 %	CR25	5322 111 34187
R17, 24	127E	1 %	MR25	5322 116 54479
R18	1K69	1 %	MR25	5322 116 54567
R19	3K65	1 %	MR25	5322 116 54587
R21	4K42	1 %	MR25	5322 116 50556
R22, 23	3K83	1 %	MR25	5322 116 54589
R25 CERMET RST	10M	5 %	CR25	5322 111 34108
R26	30K1	1 %	MR25	5322 116 54655
R27, 28, 29, 30, 31, 32, 33, 34, 35	10K	1 %	MR25	5322 116 54619
R47, 56	51E1	1 %	MR25	5322 116 54442
R48, 49, 50	121E	1 %	MR25	5322 116 54426
R51, 52, 53	237E	1 %	MR25	5322 116 50679
R54	1K78	1 %	MR25	5322 116 50515
R55	562E	1 %	MR25	5322 116 54009
Capacitors				
C1, 2	2,2 μF	−10 +50 %	63 V	5322 121 40188
C3-C11	22 μF	−20 +80 %	40 V	4822 122 30103
Integrated circuits				
D1, 2, 3	LM324N			5322 122 30103
Diodes				
V1, 2, 3	LED YELLOW	CQY96-III		5322 130 34634
V4, 5, 6, 8, 9, 10, 11, 12, 13	LED RED	CQY24B-III		5322 130 31144
V7	LED GREEN	CQY94-III		5322 130 31249
V14, 15	BAW62			5322 130 30613
V17, 19	BZX79-C12			5322 130 34197
V18	BZX79-C9V1			5322 130 30667
Transistor				
V16	BC547B			4822 130 44257

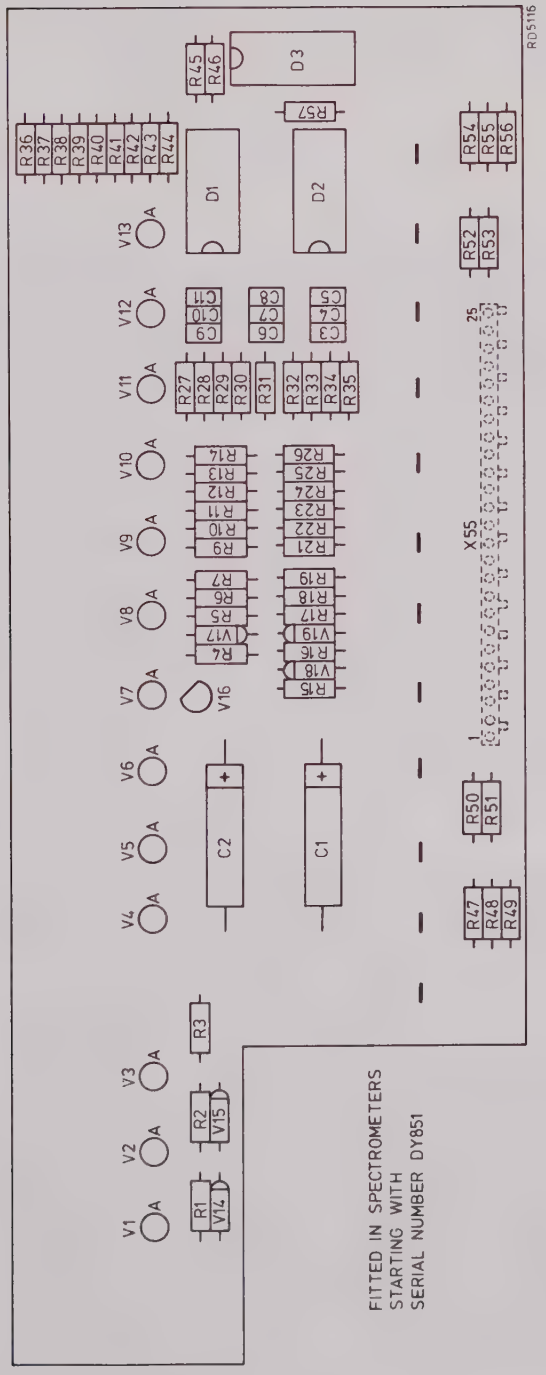
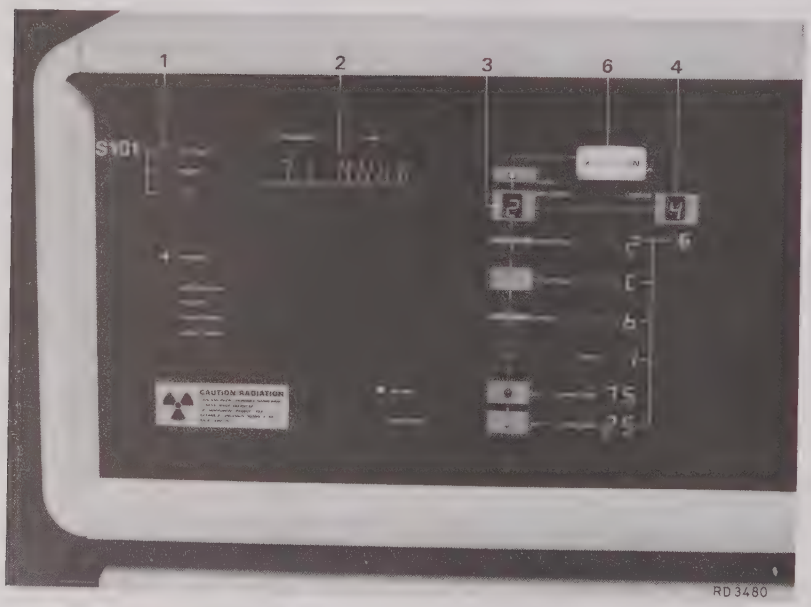


Fig. 8.1.28.1. Temperature and voltage control display

8.1.29. Front panel, left

Item	*Description*	*Ordering code*
1	Push button square 12,5	5322 414 24872
2	Window	5322 459 24079
3	Window	5322 459 24083
4	Window	5322 459 24082
5	Window	5322 459 24081
6	Lamp holder assembly X-rays on	5322 255 34099
E1	Lamp 6 V 5 W	5322 134 40144
S101	Push button switch	5322 276 34055



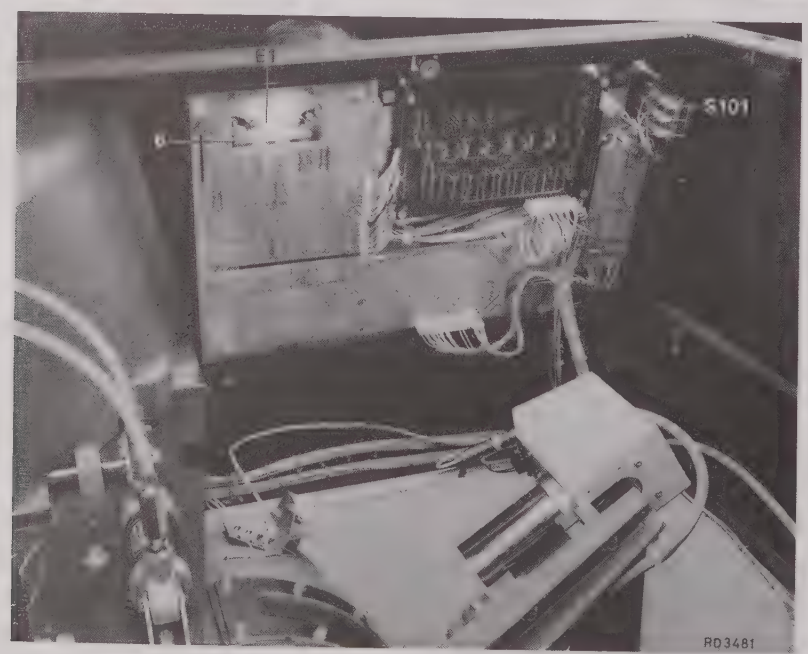
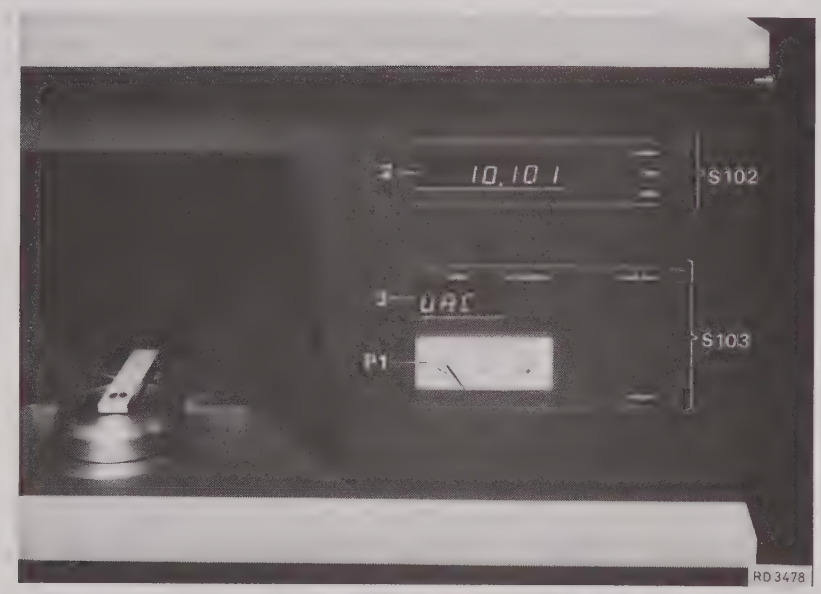


Fig. 8.1.29. Front panel left

8.1.30. Front panel, right

Item	*Description*	*Ordering code*
1	Push button square 12,5	5322 414 24872
2	Window	5322 459 24084
3	Window	5322 459 24085
P1	Moving coil meter	5322 344 64139
S102	Push button switch	5322 276 34054
S103	Push button switch	5322 276 24051



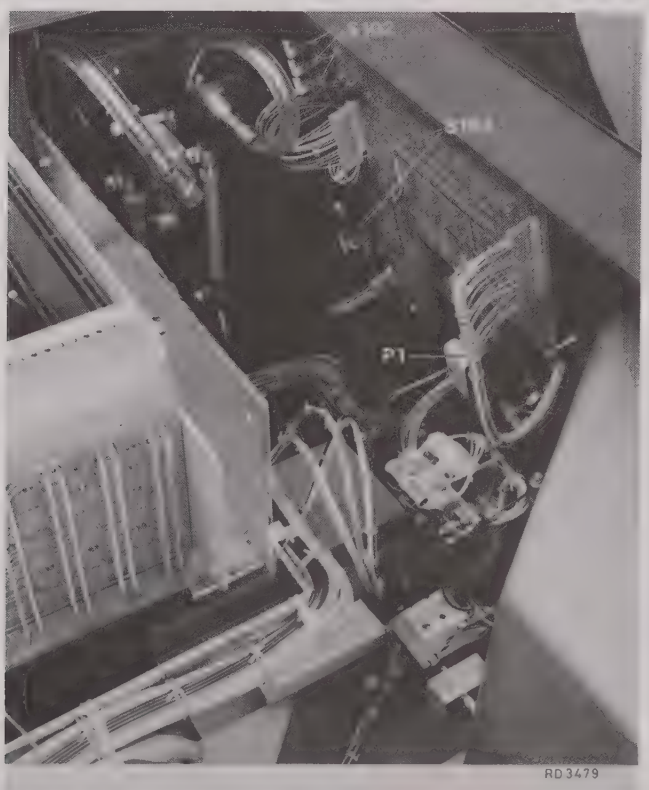


Fig. 8.1.30. Front panel right

8.1.31. Adjusting panel 2

Upto and including DY

Item	*Description*				*Ordering code*
1	Push buttonswitch				5322 276 24052
2	Potentiometer WW	10 k	5 %	2 W	5322 103 20094
3	Rotary switch type S24				5322 273 44095
4	Potentiometer Bourns	50 k	3 %	2 W	5322 103 54022
5	Counter knob for potentiometer				5322 414 74037
6	Switch knob				5322 414 34081
7	Cover for switch knob				5322 414 74021
8	Push button square 12, 5				5322 414 24872
9	Control knob				5322 414 34082
10	Cover for control knob				5322 414 74014
11	Rotary switch assy				5322 273 34112
R35	1k	1 %	MR25		5322 116 54549
R36	412 E	1 %	MR25		5322 116 54521
R37	590 E	1 %	MR25		5322 116 50561
R38	825 E	1 %	MR25		5322 116 54541
R39	1k18	1 %	MR25		5322 116 54556

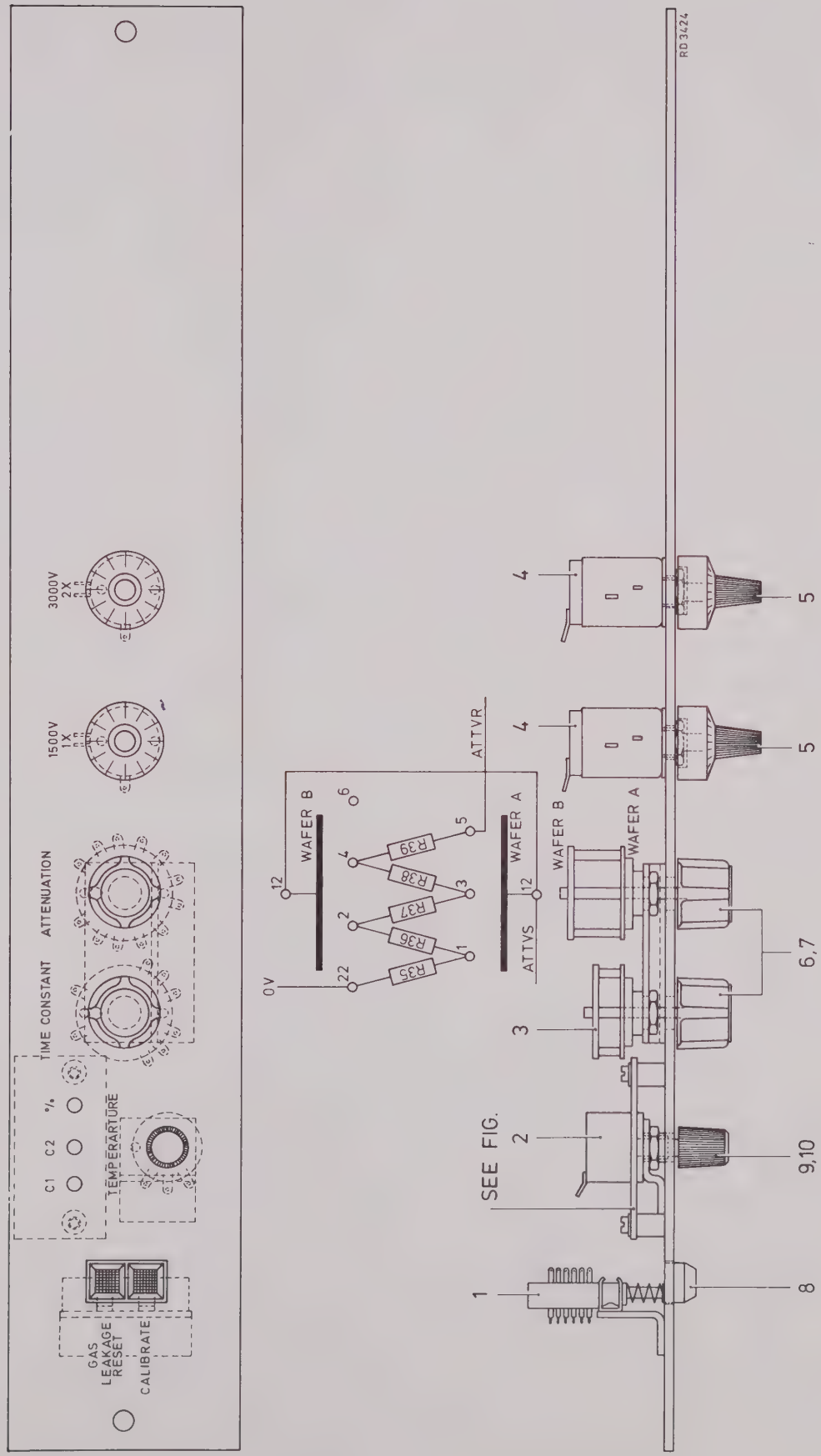


Fig. 8.1.31. Adjusting panel 2

8.1.32. Detector connection pcb A59

Item	Description			Factory code 4022 332 82600 / Ordering code 5322 694 14361 Ordering code
Capacitors				
C1, 3	10 nF	−20 +50 %	3 kV	5322 122 20009
Integrated circuits				
D1	7824CU			5322 209 85833
Resistors				
R1	249 k	1 %	MR25	5322 116 54734
R2	10 M	10 %	CR25	4822 110 63214

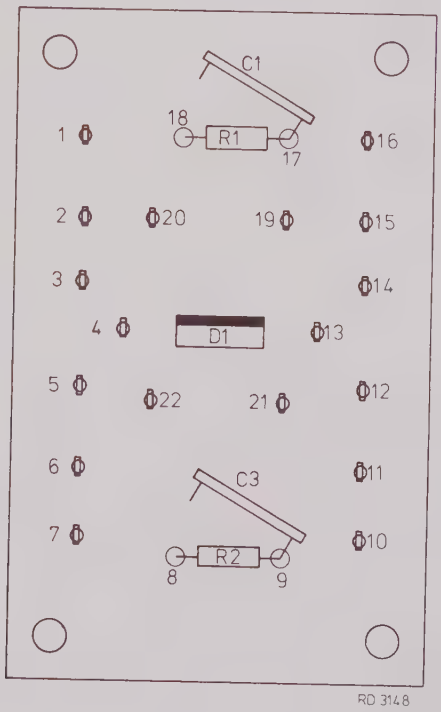


Fig. 8.1.32. Detector connection pcb

8.1.33. Display power supply pcb A63

	Factory code 4022 332 82460			Ordering code 5322 694 14356
Item	*Description*			*Ordering code*
Capacitors				
C1	33 µF	−10 +50 %	350 V	4822 124 40307
C2	150 nF	10 %	400 V	5322 121 40307
C3	10 µF	−10 +50 %	63 V	4822 124 20728
Resistors				
R1	390 E	5 %	CR25	4822 110 63096
R2	390 k	5 %	CR25	4822 110 63176
R3	560 E	5 %	CR25	4822 110 63101
R4	82 E	5 %	CR25	4822 110 73078
R5, 6	1 k	5 %	CR25	4822 110 63107
Diodes				
V1	BY179			4822 130 30521
V4	BZX75-C2V1			5322 130 34049
V5	BZX75-C2V8			5322 130 34048
V6	BZX79-C68			4822 130 30864
V7, 8	BZX79-C56			4822 130 34258
V9, 10	BAW62			4822 130 30613
V11	BZX79-C56			4822 130 34258
Transistors				
V2	BF422			4822 130 41084
V3	BUX86			5322 130 44718

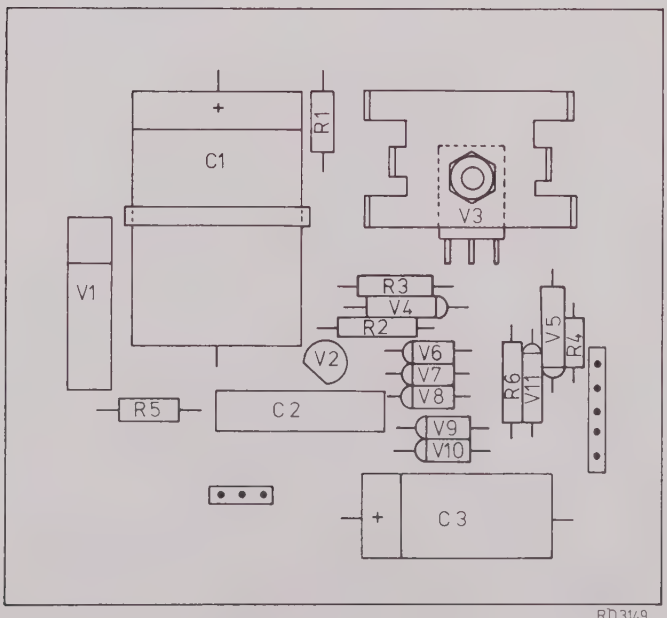


Fig. 8.1.33. Display power supply pcb

8.1.34. Scintillation detector

Factory code
4022 331 6165

Ordering code
5322 349 54018

Item	*Description*				*Ordering code*
1	Photo scintillator	B1			5322 214 74023
2	Tube base				5322 255 74018
C31, 32	Capacitor ceramic	10 nF	10 %	2 kV	5322 122 54018
R31-40	Resistor	1 M	5 %	CR25	4822 110 63187
R41	Resistor	3M3	10 %	CR25	4822 110 63201
	Auxilliary collimator complete				5322 694 14082
23	See 8.1.35				
31	Locking slide 9 pole				5322 268 44135
35	Connector 9 pole				5322 268 34032
	Connecting cable complete				5322 320 24013

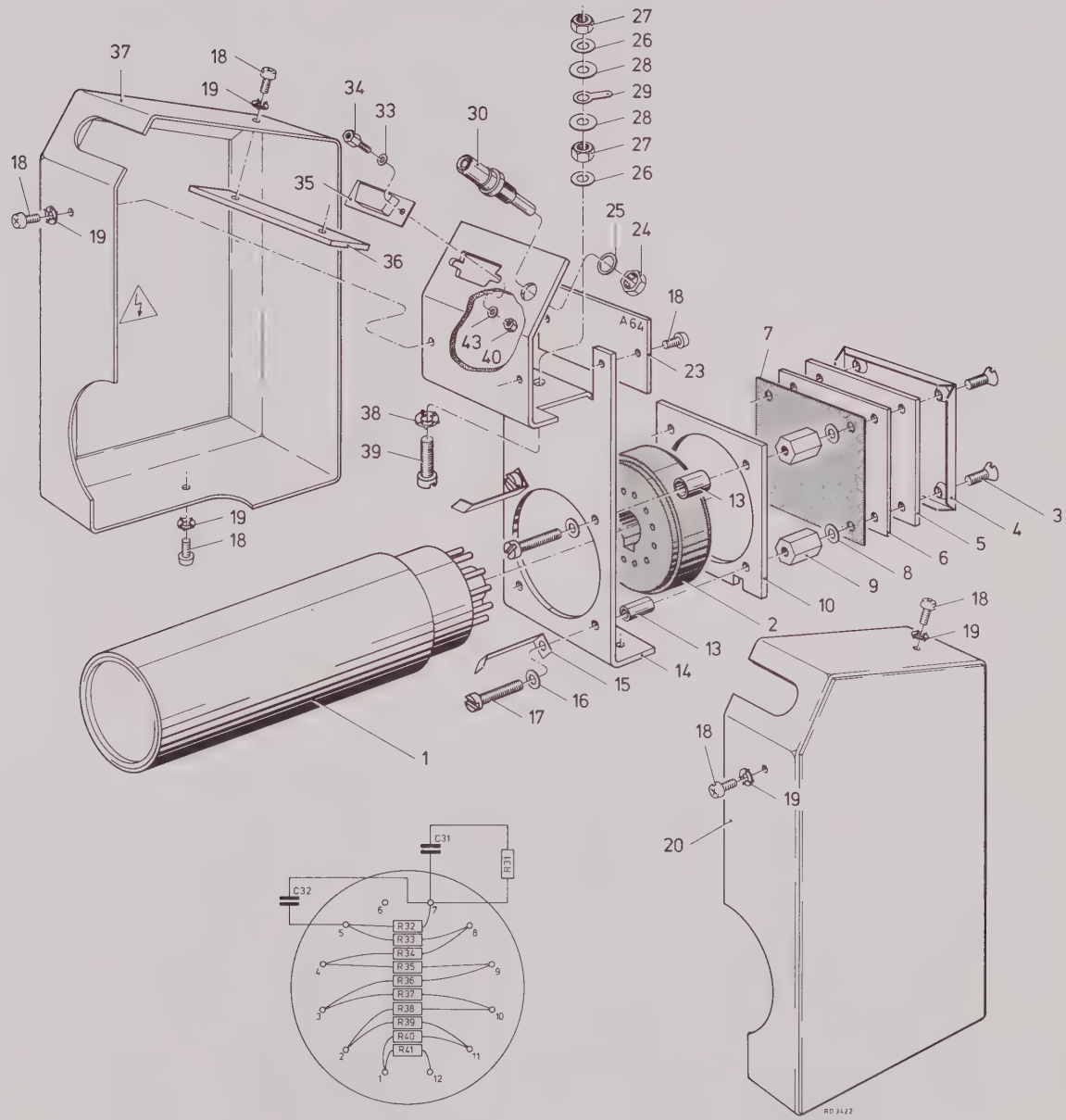


Fig. 8.1.34. Scintillation detector

8.1.35. Scintillation detector pcb A64

	Factory code 4022 332 82610			Ordering code 5322 694 14359
Item	*Description*			*Ordering code*
Thin film circuits				
A21	Charge amplifier		OM 519	5322 209 86037
Capacitors				
C21, 22	10 nF	–20 +50 %	2 kV	5322 122 54022
C24	22 nF	–20 +80 %	40 V	4822 122 30103
C23	39 pF	2%	100V	2222 631 10399
Resistors				
R21, 24	100 E	1 %	MR25	5322 116 54469
R22, 23	100 k	1 %	MR25	5322 116 54696
R26	2k74	1 %	MR25	5322 116 50636
R25,24	10 k	1 %	MR25	5322 116 54619
R27	5k11	1 %	MR25	5322 116 54595
R28	64E9	1 %	MR25	5322 116 54453
R29	1k	1 %	MR25	5322 116 54549
R30	11k5	1%	MR25	5322 116 54624
Transistors				
V21	BFY90			5322 130 40493

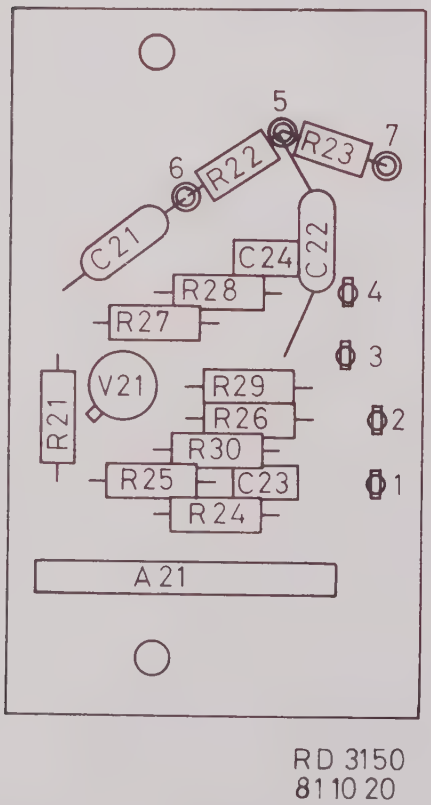


Fig. 8.1.35. Scintillation detector pcb

8.1.36. Fuse panel assembly

Item	*Description*	*Ordering code*
1	Klixon temperature cutout	5322 282 54058
2	Fuse holder	5322 256 34079

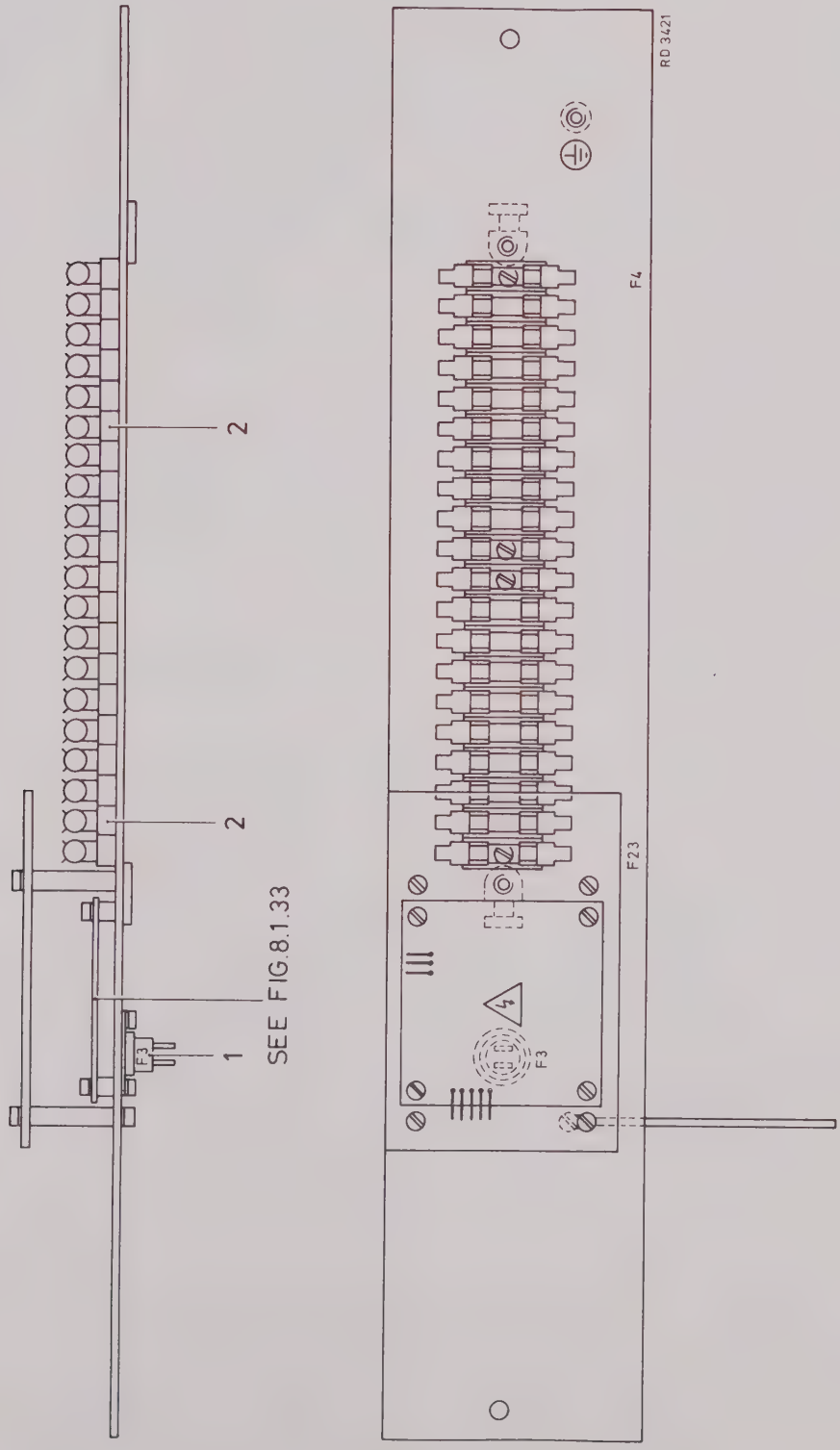


Fig. 8.1.36. Fuse panel assembly

8.1.37. Electrical rack lower

Item	*Description*	*Ordering code*
1	Mica plate 56201D	5322 255 44251
2	Insulating tube 56261	5322 532 50628
3	Ceramic tube 3X1,5	5322 532 50899
4	Ceramic tube 3X6	5322 532 60487
5	Heatsink compound	5322 390 20019
6	Insulating set 56351	4822 255 40138
V1, 2	Transistor BDX65A $29.90	4822 130 40997

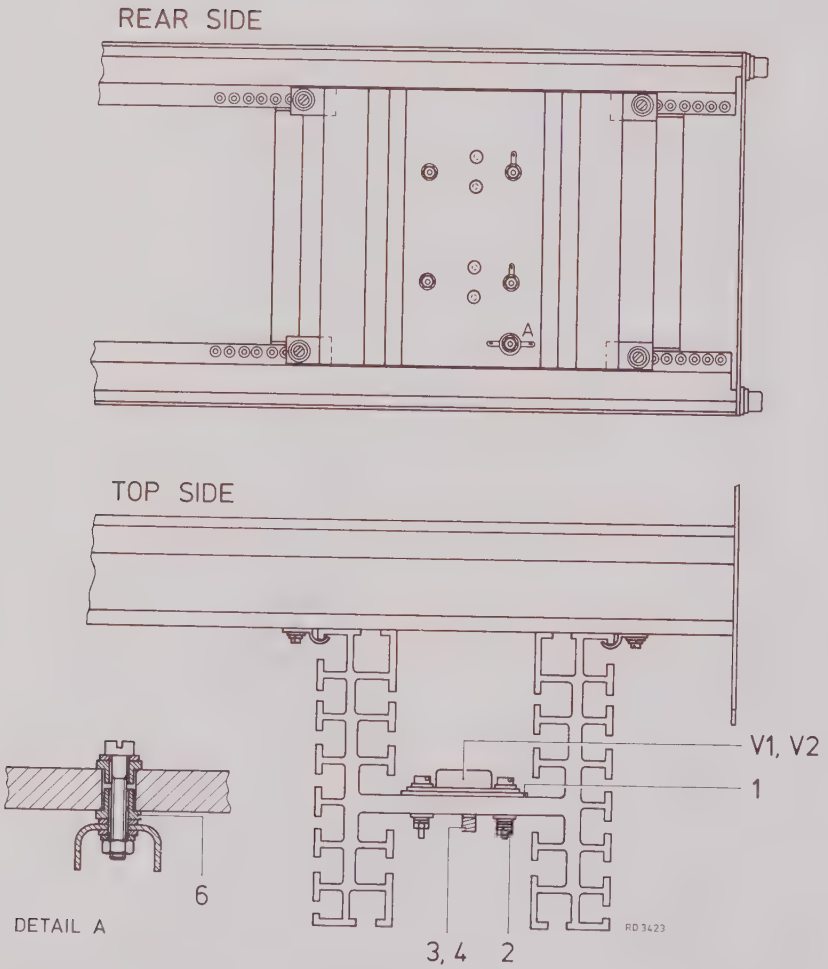
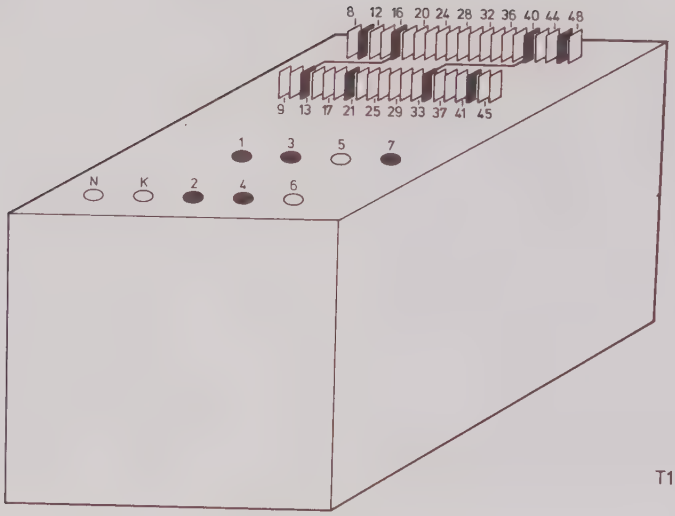
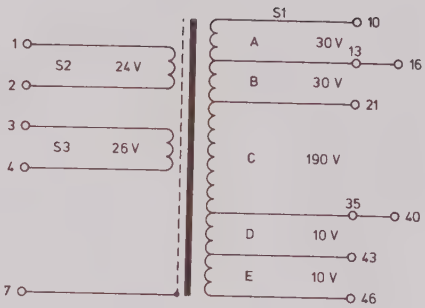


Fig. 8.1.37. Electrical rack lower

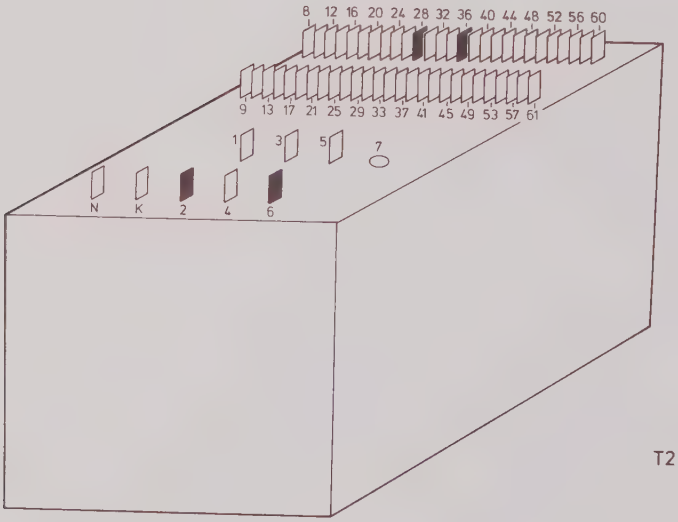
8.1.38. Spectrometer electrical

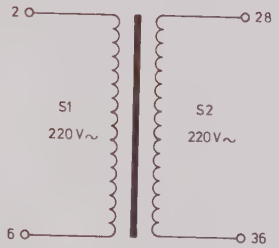
Item	*Description*		*Ordering code*
1	Micro switches S31-38	S31-38	5322 271 34193
2	Transformer TE2535	T1	5322 146 14153
3	Transformer TE3235	T2	5322 146 14154
4	Transformer TE2550	T3	5322 146 84011
5	Relay 24 V 50/60 Hz	Q1	5322 280 44049
6	Solid relay 240-D10	V1, 2	5322 280 74108
7	Fuse holder E27	25 A	5322 256 40037
8	Screw cap for holder E27	25 A	5322 256 50014
9	Fitting screw E27	10 A	5322 256 50006
10	Fuse T-D-E27	10 A	5322 254 40003
11	Socket for shorting plug	S44	5322 267 30231
12	Fan		5322 361 14043



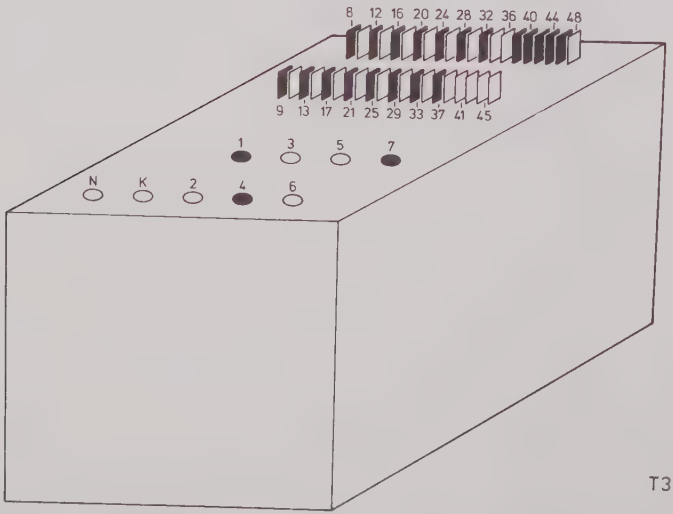


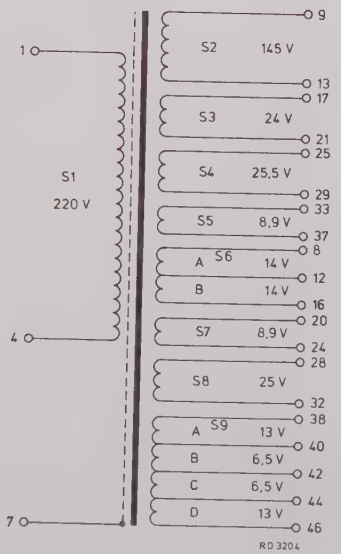
T1





T2





T3

Fig. 8.1.38. Spectrometer electrical

8.1.39. Cables and wires

Item	*Description*	*Ordering code*
1100	High voltage Coaxial cable 19 x 0, 1 x 100 M	5322 320 24012
1101	HF Coaxial cable 75 E	5322 320 14101
1102	Spiral protective Sleeve nylon 6,1 per meter	5322 530 24091

8.1.40. Connectors (including those on pcb's)

Item	*Description*	*Ordering code*
1001	Header strip 50-pole 90DEG AMP5-825437-0	5322 265 64093
1002	Header strip 50-pole 180DEG AMP5-825433	5322 265 64091
1003 X1-11, X24, X50-55, X63	Contact block MOD 4 50-pole pin AMP5-925369-0	5322 265 64092
1004	Contact MOD 4 0,14 x 0,56 MM SQ AMP-141603-3	5322 268 24108
1005	Polarizing key MOD 4 AMP-87077-2	5322 268 14136
1006	Housing 96-pole MOD 4 AMP-925468	5322 268 44141
1007	Contactor tandem Spring MOD 4 AMP-530151-8	5322 290 34115
1008	Locking clip housing 1-pole AMP-87175-2	5322 492 64662
1009 X15-C, X21, X67	Locking clip housing 5-pole AMP-1-87175-2	5322 492 64663
1010 X13, X14, X23	Locking clip housing 15-pole AMP-87175-3	5322 492 64664
1011	Printed wiring-connector 64-pole-2, 54MM Type F068-1 Panel part Elcoma	5322 265 64009
1012	Printed wiring-connector 32-pole-5, 08MM Type F068-1 Panel part Elcoma	5322 265 64095
1013	Printed wiring-connector 64-pole-2, 54MM Type F068-1 Board part Elcoma	5322 265 64082
1014	Connector RH 32-pole Type F068-1 Board part Elcoma	5322 268 14033
1015	Printed wiring-connector 32-pole-5, 08 Type F068-1 Board part Elcoma	5322 265 64094
1016 X64, X70	Connector block RH 9-pole socket AMP-20503-1	5322 267 54164
1017 X66-68, X81-84, X102	Connector block RH 15-pole socket AMP-205205-1	5322 267 54154
1018 X19, X20, X44, X103 X104, X111	Connector block RH 25-pole socket	5322 267 54149

Item	*Description*	*Ordering code*
1019 X48, X47	Contact block RH 37-pole socket AMP-205209-1	5322 267 74081
1020 X49, X46	Connector block RH 50-pole socket AMP-205211-1	5322 267 74084
1021	Contact socket	5322 268 24102
1022 X64, X70	Connector block RH 9-pole pin AMP-205204-1	5322 268 34032
1023 X66-68, X81-84, X102	Connector block RH 15-pole pin AMP-205206-1	5322 265 44082
1024 X19, X20, X44, X103, X104, X111	Connector block RH 25-pole pin AMP-205207-1	5322 265 54044
1025 X47, X48	Connector block RH 37-pole pin	5322 265 64097
1026 X45, X46	Connector block RH 50-pole pin	5322 265 64098
1027	Contact pin	5322 268 14133
1028	Polarizing key HDP20 AMP-206509-1	5322 268 14134
1029	Cap 9-pole AMP-205729-1	5322 268 44132
1030 X68	Cap 15-pole AMP-205730-1	5322 268 44131
1031	Cap 25-pole AMP-205718-1	5322 268 44129
1032	Cap 37-pole AMP-205731-1	5322 268 44133
1033	Cap 50-pole AMP-205732-1	5322 268 44134
1034 X64	Locking slide 9-pole	5322 268 44135
1035 X67, X68	Locking slide 15-pole AMP-164641-2	5322 268 44136
1036	Locking slide 25-pole AMP-164641-3	5322 268 44137
1037	Locking slide 37-pole AMP	5322 268 44138
1038	Locking slide 50-pole AMP	5322 268 44139
1039	Special screw AMP206514-1	5322 502 64048
1040	Adapter Elcoma	5322 263 64007
1041	Printed wiring connector socket C1S 3-pole top 2, 5MM AMP-163680-1	5322 265 54006
1042	Printed wiring connector socket C1S 6-pole top 2, 5MM AMP-163680-4	5322 265 54006
1043 X212	Connector female 4-pole 10 A tuchel 3111-000	5322 267 44009
1044 X42, X43	Socket connector	5322 267 14032
1045 Fig. 8.2.3. it. 43	Connector block screw Type 3-pole Wieland 8006/3DSKR	5322 290 64152
1046 X70, X112	Connector block screw Type 4-pole Wieland 8006/4DSKR	5322 290 64152
1047	Connector block screw Type Wieland KS011/1ZKR	5322 290 64205

Item	*Description*	*Ordering code*
1048	IC connector 14-pole AMP-1-380859-2	5322 255 44073
1049	IC connector 24-pole 1 A T1 C932402	5322 255 44109
1050	IC connector 40-pole T1 C934002	5322 209 84872
1051	Display socket Sperry Rand CS-352	5322 255 74016
1052	Transistor holder	5322 255 44048
1053	Relay socket FR 10 V	5322 255 64024
1054	Retaining spring HF103	5322 267 74021
1055	Test socket double	5322 267 34074
1056	Coaxial connector	5322 268 14023
1057	Solder cup socket AMP-66569-3	5322 268 24106
1058	Insulating tube 56201C	5322 466 90433
1059	Locking clip contact 0,12 x 0,4 MM SQ AMP-87165-1	5322 268 24107
1060	Locking clip polarizing key	5322 492 64665
1061	Connector block X101 2-pole screw Type	5322 290 60154
1062	Connector block 2-pole screw Type	5322 290 64152
1063	Connector strip KK-4	5322 290 64215
1064	Shield grounding lug Amphenol 31-759	5322 290 44035

8.2. MECHANICAL

8.2.1. Parts delivered with PW1400/00.

Item	*Qty.*	*Description*		*Factory code number*	*Service code number*
4	1	Reduction valve		4022 196 06780	5322 360 50125
82	10	Sealing water for gas cylinder		4022 189 98360	5322 532 54208
121	1	Straight pipe coupling 4x4		2922 006 09001	5322 526 44031
2	4m	Copper pipe		4022 189 97970	5322 530 44018
17	4	Sample holder		PW1427/00	
111	1	Cu sample		4022 189 66470	5322 397 60035
112	1	Al sample		4022 189 43740	5322 466 80384
113	1	Ni Fe sample		4022 332 09920	5322 397 64009
6	1	Auxillary collimotor		4022 188 23660	5322 694 14082
16	1	Crystal chamber window		4022 331 60830	5322 459 44001
18	1	Flow detector window 6 micron		PW1417/06	–
78	10m	Magno nickel wire for flow detector		0222 093 01019	5322 694 14384
77	12	Conical pins for flow detector		4022 910 87580	
75	2	Contact spring for gas flow detector		4022 189 50210	5322 492 50801
7	1	Balance weight		4022 332 23400	–
3	1	Bottle of oil Tellus 33 for goniometer worm house		4022 189 45120	5322 390 10006
61	1	Vacuum grease Apiezon. for static seals		1322 504 76302	5322 390 20017
14	1	Molykote grease 44 for dynamic seals		4022 331 63400	5322 390 24014
63	1	Silicone grease for HT connector		1312 501 48202	5322 390 20011
20	20m	Water hose		0822 046 19008	5322 530 24099
88	10	Hose clampe 14x8		2522 713 01001	4822 401 10257
13	1	Transparent crystal chamber window		4022 331 61830	5322 466 64188
87	1	Special key (crystal adjustment)		4022 331 61820	5322 395 94044
62	1	Special key (collimator adjustment)		4022 188 22660	5322 694 14081
86	1	Shaft		4022 322 14100	
86	2	Washer (Stepping motor adjustment)		2522 600 16147	5322 5359 94943
86	2	Nut		2522 401 60013	
11	1	Gear box for spinner (60Hz)		4022 332 13130	4322 522 14082
80	1	Mask 28mm		4022 332 14070	5322 525 14012
81	1	Mask 24mm		4022 332 14080	5322 525 14013
22	2	O-ring Gaco	R4800	2622 080 30869	5322 530 54566
23	2	O-ring	Special	4022 198 05130	5322 530 54097
24	2	Quad ring MINN 4011		2622 080 90736	5322 532 54423
25	3	O-ring PRP	224	2622 080 90733	5322 530 54568
26	2	O-ring	Special	4022 198 05180	5322 530 54103
27	2	O-ring Gaco	R4143	2622 080 30796	5322 530 50472
28	2	O-ring	Special	4022 198 05190	5322 530 54104
29	2	O-ring Gaco	R3075	2622 080 30745	5322 530 50471
30	2	O-ring Gaco	R3275	2622 080 30781	5322 530 54335
31	2	Quad ring MINN	4111	2622 080 90487	5322 532 54421
32	2	O-ring PRP	141	2622 080 90564	5322 530 54094
33	2	Quad ring MINN	4010	2622 080 90821	5322 530 54351
34	2	Quad ring MINN	4008	2622 080 90735	5322 532 54408
35	2	O-ring PRP	142	2622 080 90565	5322 530 54093
36	2	O-ring Gaco	R4100	2622 080 30878	5322 530 54011

Item	Qty.	Description		Factory code number	Service code number
37	2	O-ring PRP	007	2622 080 90732	5322 530 54567
38	2	Quad ring MINN	4111	2622 080 90737	5322 532 54424
105	1	Vacuum seal	1θ	4022 189 67530	5322 532 60491
104	1	Vacuum seal	1θ	4022 189 67520	5322 532 60489
103	5	Fuse	16A	2422 085 01012	5322 254 40006
102	5	Fuse	10A	2422 085 01009	5322 254 40003
98	3	Cartridge fuse	6,3A	2422 086 01136	4822 253 30031
114	2	Lamp (front panel)	6V 5W	9236 342 10101	5322 134 40144
65	1	Allen key	1.27	2622 150 09003	5322 395 54078
66	1	Allen key	2.5	2622 150 09009	4822 395 50085
67	1	Allen key	2	2622 150 09007	4822 395 50984
68	1	Allen key	3	2622 150 09011	4822 395 50013
69	1	Allen key	4	2622 150 09014	4822 395 50014
70	1	Allen key	5	2622 150 09016	4822 395 50015
71	1	Allen key	6	2622 150 09018	4822 395 50019
72	1	Allen key	10	2622 150 09024	5322 395 54079
107	2	Filter for air lock		4022 189 78370	5322 480 44007
106	25	Filter for detector gas		2822 060 20417	5322 480 40042
115	20	Contact socket 0.12 x 0.4 mm^2		2422 034 11886	5322 268 24107
116	10	Contact socket MOD4 0.14 x 0.56 mm^2		2422 034 11888	5322 268 24108
117	20	Contact pin round 0.2 x 0.6 mm^2		2422 034 11634	5322 268 14133
118	10	Contact socket round 0.2 x 0.6 mm^2		2422 034 11629	5322 268 24102
119	10	Contact socket MOD4 0.12 x 0.35 mm^2		2422 015 12598	5322 290 34115
97	3	Lamp (stand.)	6V 5W	9234 021 10101	5322 134 44197
	1	Extension and assay		4022 331 66400	5322 263 74141
90	1	Connection cable between PW 1400 - PW 1730		4022 332 66430	
64	1	Screw driver	2.3	2622 150 11029	
39	2	O-ring PRP	031	2622 080 05753	5322 530 54579
40	2	O-ring Gaco	R153	2622 080 30805	5322 530 54014
41	2	O-ring Gaco	R4500	2622 080 30852	5322 530 54015
42	2	O-ring Gaco	R4750	2622 080 30867	5322 530 54016
43	2	O-ring Gaco	R106	2622 080 30708	5322 530 50503
44	2	O-ring Gaco	R165	2622 080 30814	5322 530 54008
45	2	O-ring Gaco	R4137	2622 080 32744	5322 530 54581
46	2	O-ring Gaco	R2093	2622 080 30722	5322 530 50508
47	2	O-ring Gaco	R4100	2622 080 30787	5322 530 50479
48	2	O-ring	Special	4022 198 05160	5322 530 54101
49	2	O-ring Gaco	R2087	2622 080 30721	5322 530 50457
50	2	O-ring Gaco	RM0395 -30	2622 080 30057	5322 530 54565
51	2	Quad ring MINN	4110	2622 080 90641	5322 530 54339
52	2	O-ring Gaco	R117	2622 080 30737	5322 530 54296
53	2	O-ring Viton 2,62x120,32		4022 199 01580	5322 530 54013
54	2	Quad ring MINN	4222	2622 080 90625	5322 530 54422
55	2	O-ring Gaco	R4106	2622 080 32738	5322 530 54582
109	1	Extraction tool for LC contacts		2622 540 09045	5322 395 94062
108	1	Extraction tool for HDP20 contacts		2622 540 09094	5322 395 94061

Item	*Qty.*	*Description*	*Factory code number*	*Service code number*
110	1	Extraction tool for MOD4 contacts	2622 540 09379	5322 395 94063
85	2	Coupling nut with olive 12 x G 1/2	2622 007 02215	5322 526 44223
84	6	Hose coupling 12 x 3/8	2922 014 09009	5322 526 44183
83	1	Microswitch override tool.	4022 331 66930	5322 310 34108
91	1	Null modem	4022 331 69020	–
76	1	Pipe support 8x6	2922 007 03015	5322 532 24513
73	2	Hose coupling 8x1/4	2922 014 09008	5322 526 44182
1	1	Crystal changer	4022 331 61400	5322 694 14383
5	3m	Compressed air hose	0822 111 05004	5322 530 20055
8	1	Scintillation – detector	4022 331 61650	5322 349 54018
9	1	Photoscintillator tube	4022 334 01040	5322 214 74023
10	1	Mounting ring	4022 331 52270	–
12	1	Fuse panel (may be built in generator)	4022 331 70110	–
15	1	Extension pcb	4022 331 66400	5322 263 74141
19	1	Vacuum pump oil		
21	1	Water bypass	4022 331 69380	5322 360 54078
74	1	4mm pipe union	2922 006 09001	5322 526 44031
79	1	Hose clampe 17x11	2522 713 01002	5322 401 14272
89	1	Cable for chart recorder	4022 332 65660	–
92	1	X-rays on lamp standard	4022 331 70070	–
122	21	Cartridge fuse 4A(T)	2422 086 00344	4822 253 30028
183	9	Cartridge fuse 1,6A(T)	2422 086 00342	4822 253 30024
124	6	Cartridge fuse 200mA(T)	2422 086 00332	4822 253 30012
125	3	Cartridge fuse 50mA(T)	2422 086 00323	4822 253 30003
126	18	Cartridge fuse 1 A(T)	2422 086 00338	4822 253 30021
127	3	Cartridge fuse 3,15A(F)	2422 086 00289	4822 253 20025
128	9	Cartridge fuse 1A(F)	2422 086 00316	4822 253 20018
129	21	Cartridge fuse 500mA(F)	2422 086 00281	4822 253 20014

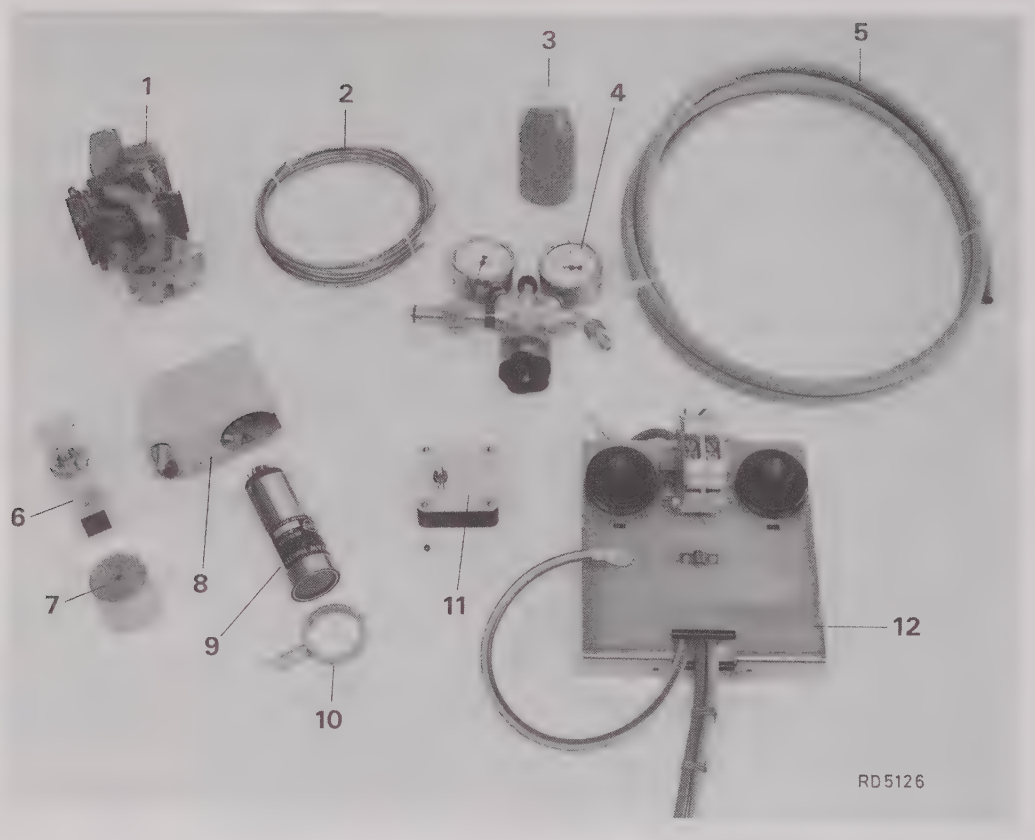


Fig. 8.2.1.1.

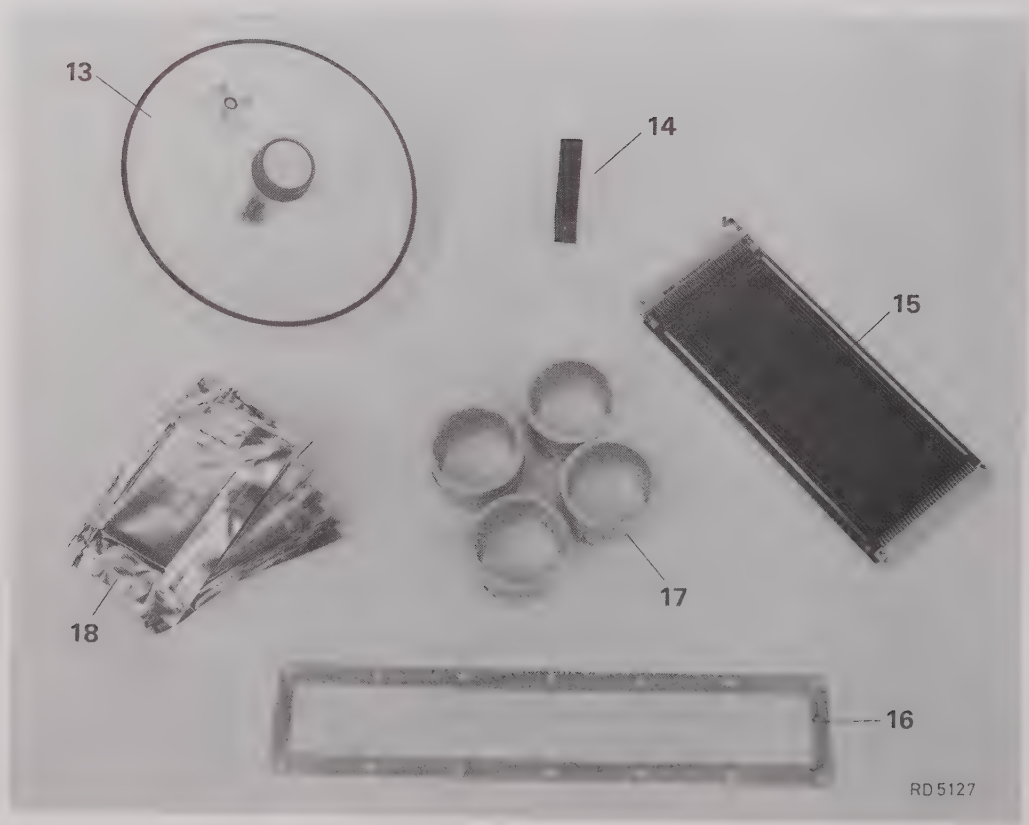


Fig. 8.2.1.2.

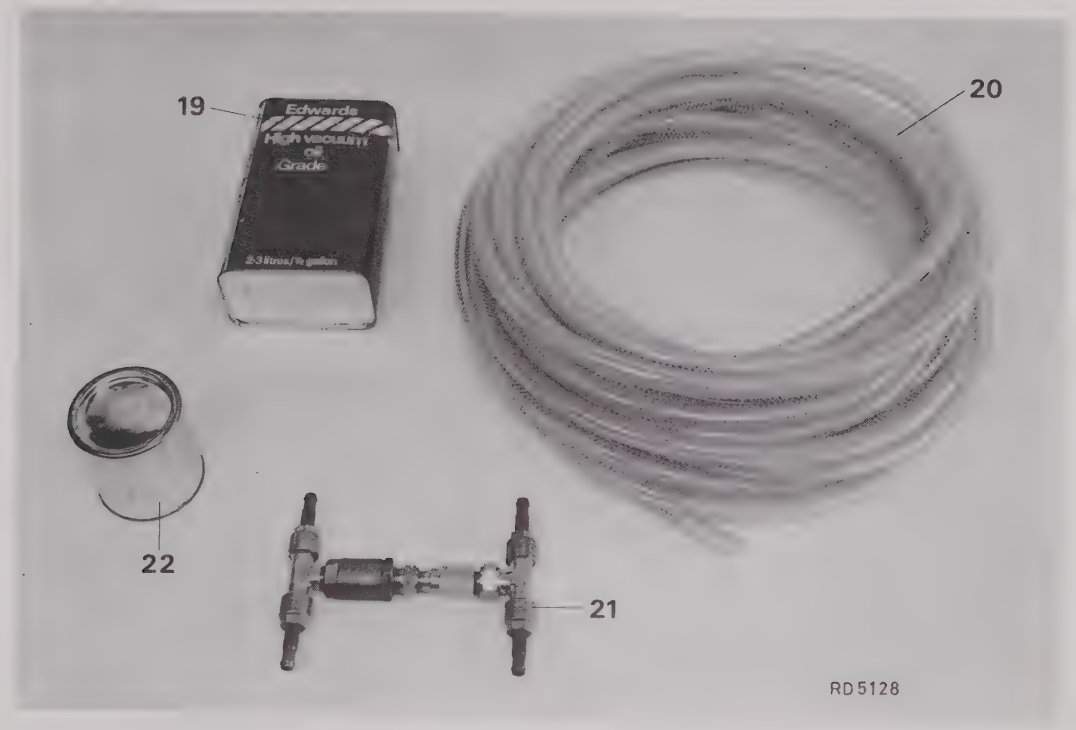


Fig. 8.2.1.3.

Fig. 8.2.1.4.

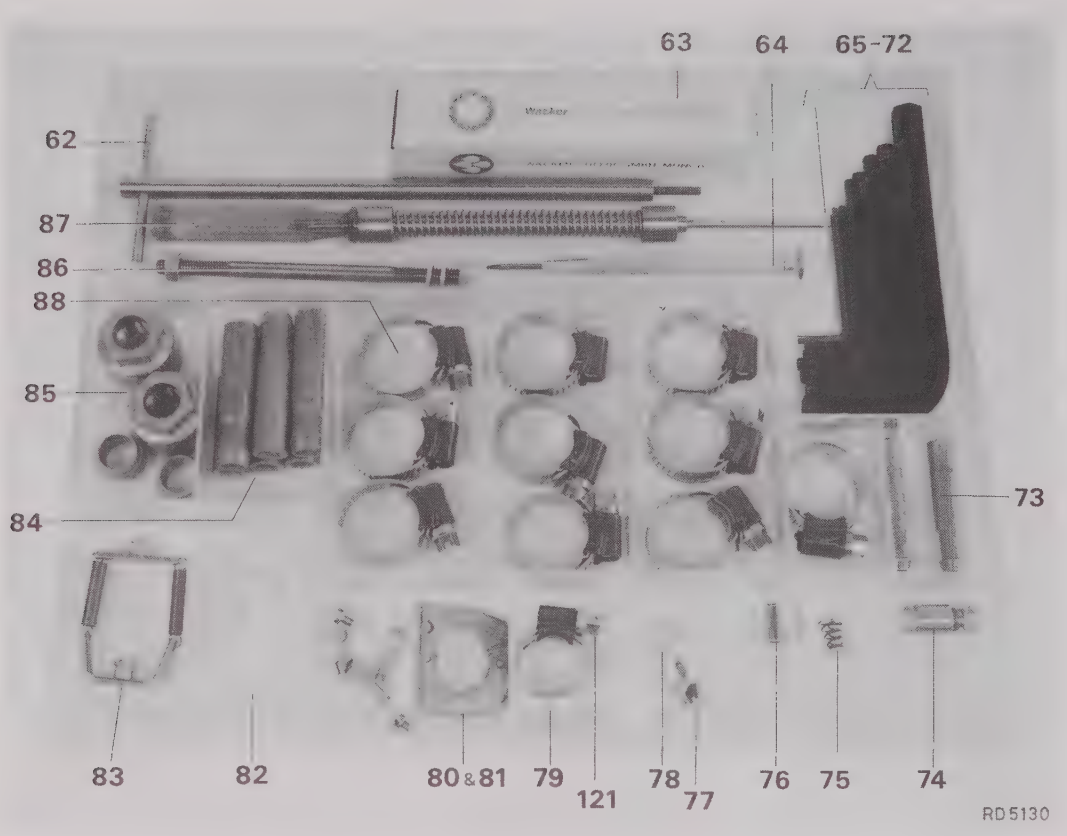


Fig. 8.2.1.5.

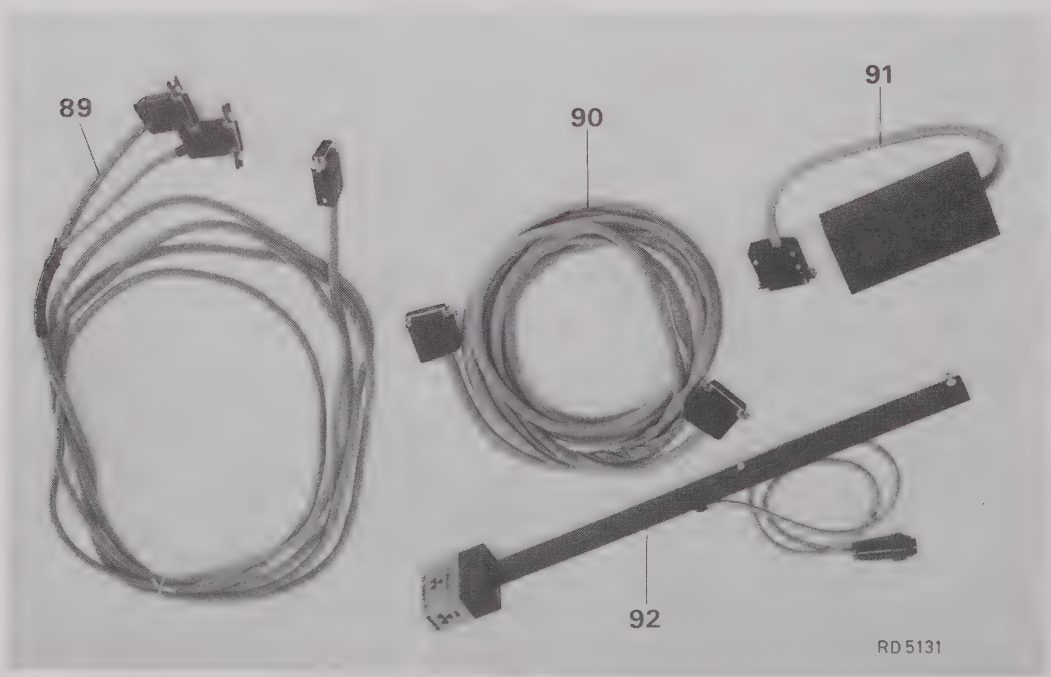
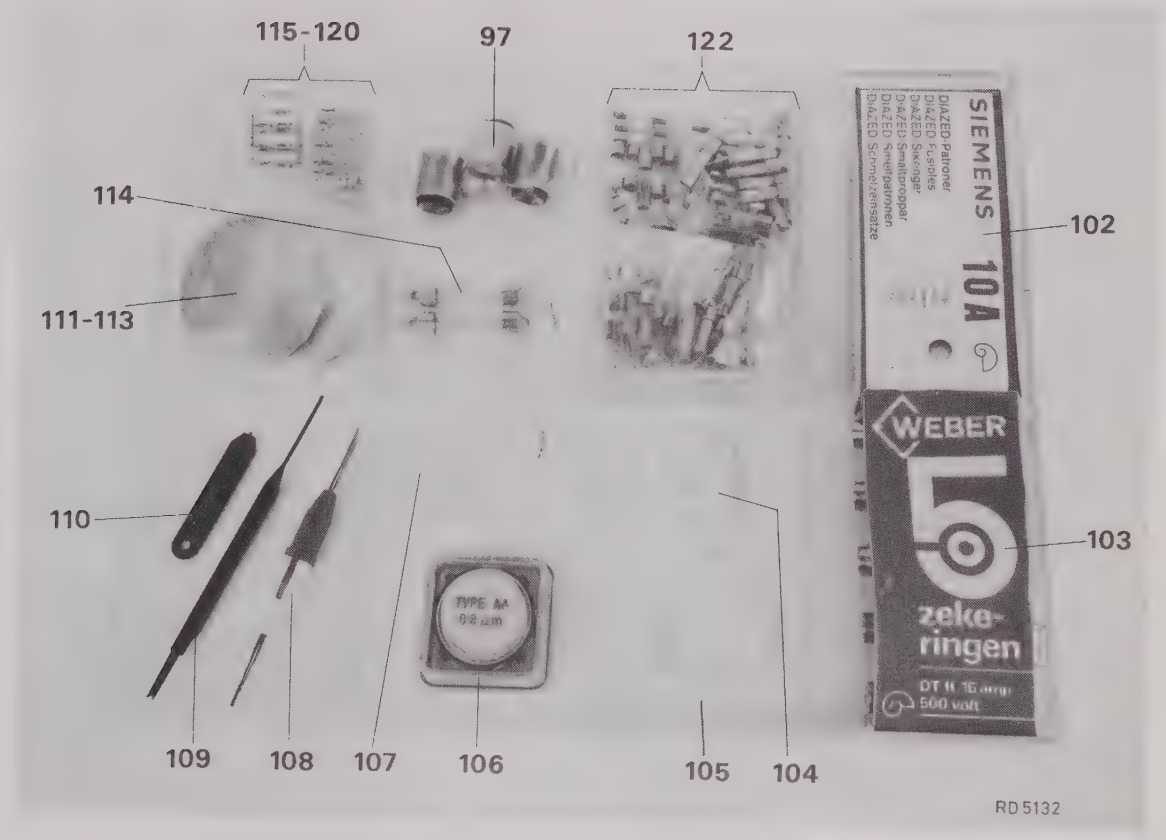


Fig. 8.2.1.6.


115-120
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RD 5132

Fig. 8.2.1.7.

8.2.2. Crystal chamber

Item	*Description*	*Ordering code*
4	Crystal chamber window	5322 459 44001
5	O-ring gaco R4800	5322 530 54566
7	Retaining ring 6 MM	4822 530 70126
8	O-ring special	5322 530 54097
15	Gearwheel	5322 522 34768
18	Pressure pad M5	5322 532 14655
27	Bearing shaft	5322 535 84441
29	Gearwheel	5322 522 34767
37	Adjustable linkage	5322 405 74024
39, 69	Microswitch	5322 271 34226
43	Blade spring	5322 492 64747
47	Actuator 6020/50	5322 360 44057
48, 50, 80	Adjustable linkage	5322 405 74023
49-64	Gas leak detector	5322 281 24026
54	Pipe connector 0,123 INCH Gas	5322 526 44153
55	O-ring gaco RM0051-16	5322 530 54382
57	N.T.C. resistor	5322 116 34048
63	Connector block	5322 290 64206
65	O-ring gaco R117	5322 530 54296
66	Vacuum measuring head	5322 526 44145
76	O-ring R4500	5322 530 54015
88	Adaptation nipple 5 x 1/8	5322 526 44112
95	Schock absurber assembly	5322 694 14536
111	Banjo coupling	5322 526 44111

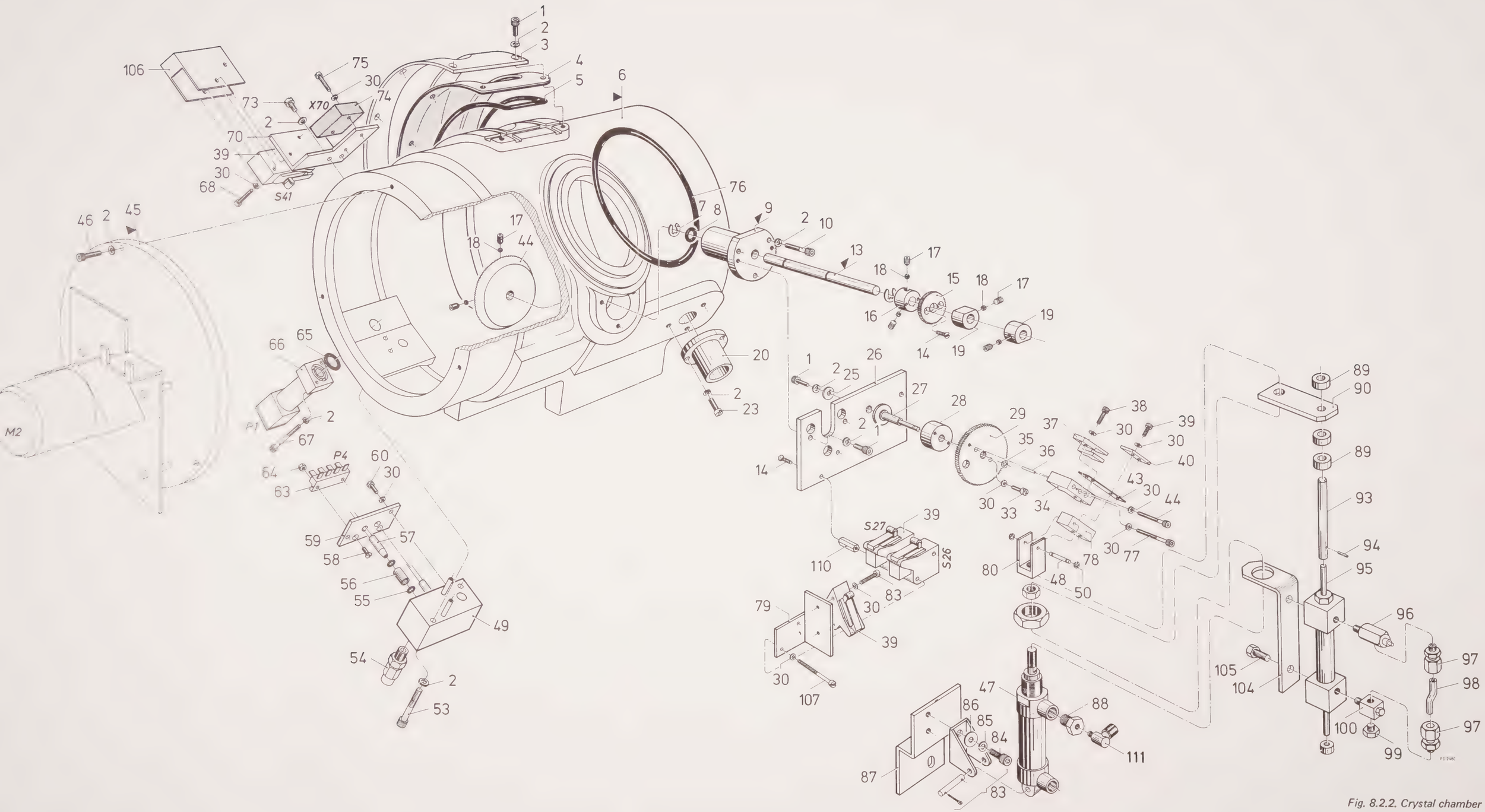

Fig. 8.2.2. Crystal chamber

8.2.3. Crystal chamber cover

Item	*Description*	*Ordering code*
3	Quadring 4011 7,65 x 1,78 mm	5322 532 54423
5	Ball bearing 8x22x7	5322 520 20065
6	Shaft	5322 535 94882
7	Circlip external 8 mm	4822 530 70035
8	Circlip internal 22 mm	4822 530 70019
9	Spring dowel 1,5 x 8 mm	5322 529 50037
10	Gearwheel 15 T	5322 522 34764
13	O-ring gaco R4750	5322 530 54016
17	Gearwheel 90 T	5322 522 34774
23	Microswitch assembly	5322 271 34227
26	Gearbox with pinion 1 : 50	5322 522 14083
27	Motor	5322 361 84208
33	Spring dowel 2,5 x 20 mm	5322 535 14147
38	Ball bearing 3 x 10 x 4 mm	5322 520 20044
40	Contact block 15-pole AMP-205206-1	5322 265 44082
	Contact pin AMP-66570-3	5322 268 14135

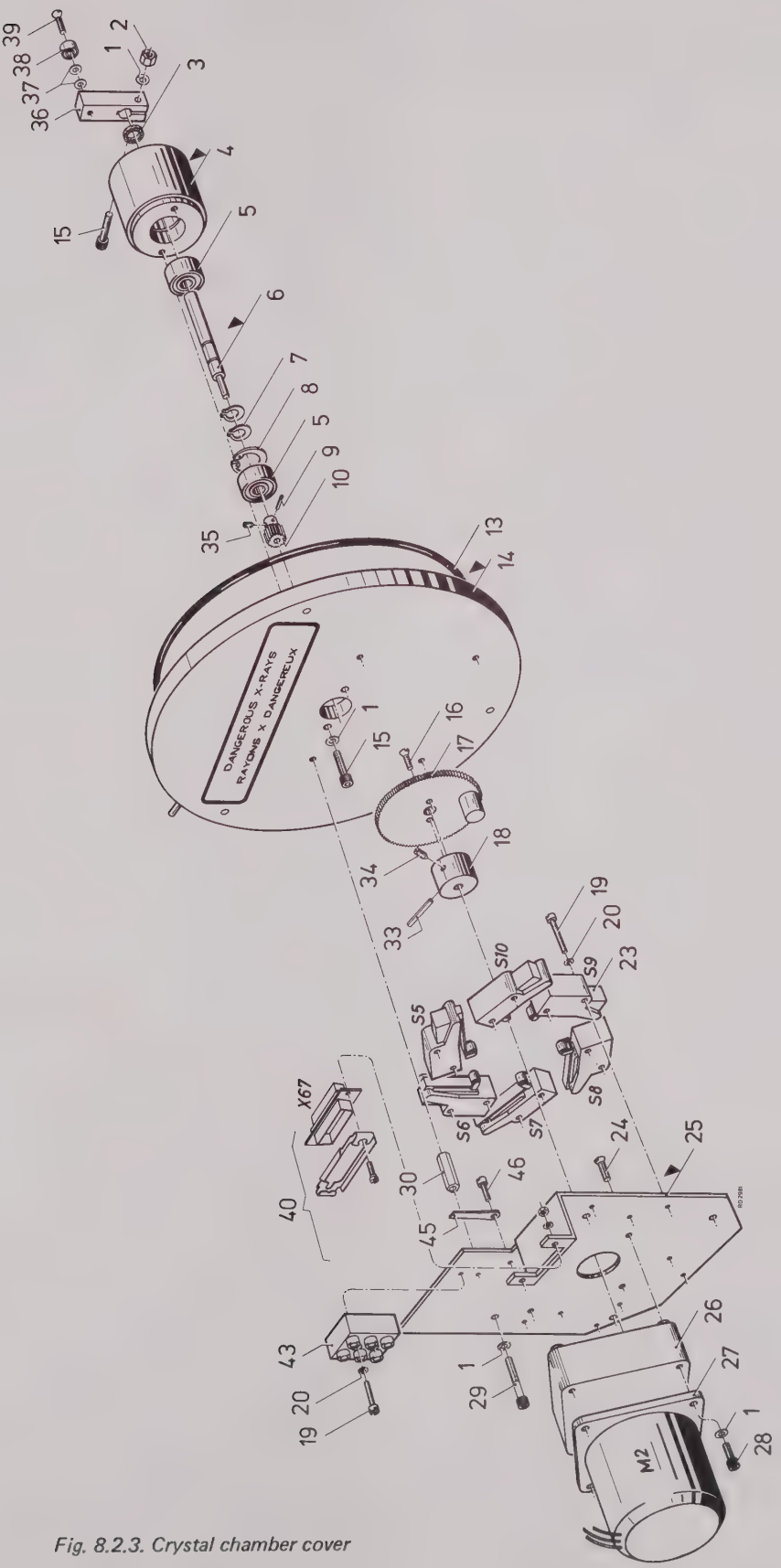

Fig. 8.2.3. Crystal chamber cover

8.2.4. Transparent crystal chamber cover

Item	*Description*	Ordering code 5322 466 64188 *Ordering code*
6	Quadring 4011 7,65 x 1,78	5322 532 54423
7	O-ring Gaco R4750	5322 530 54016
9	O-ring Gaco R106	5322 530 54118
13	Screwdriver for crystal adjustment	5322 395 94044
16	Operating knob	5322 414 64096
23	Ball bearing single row 3 x 10 x 4	5322 520 20044

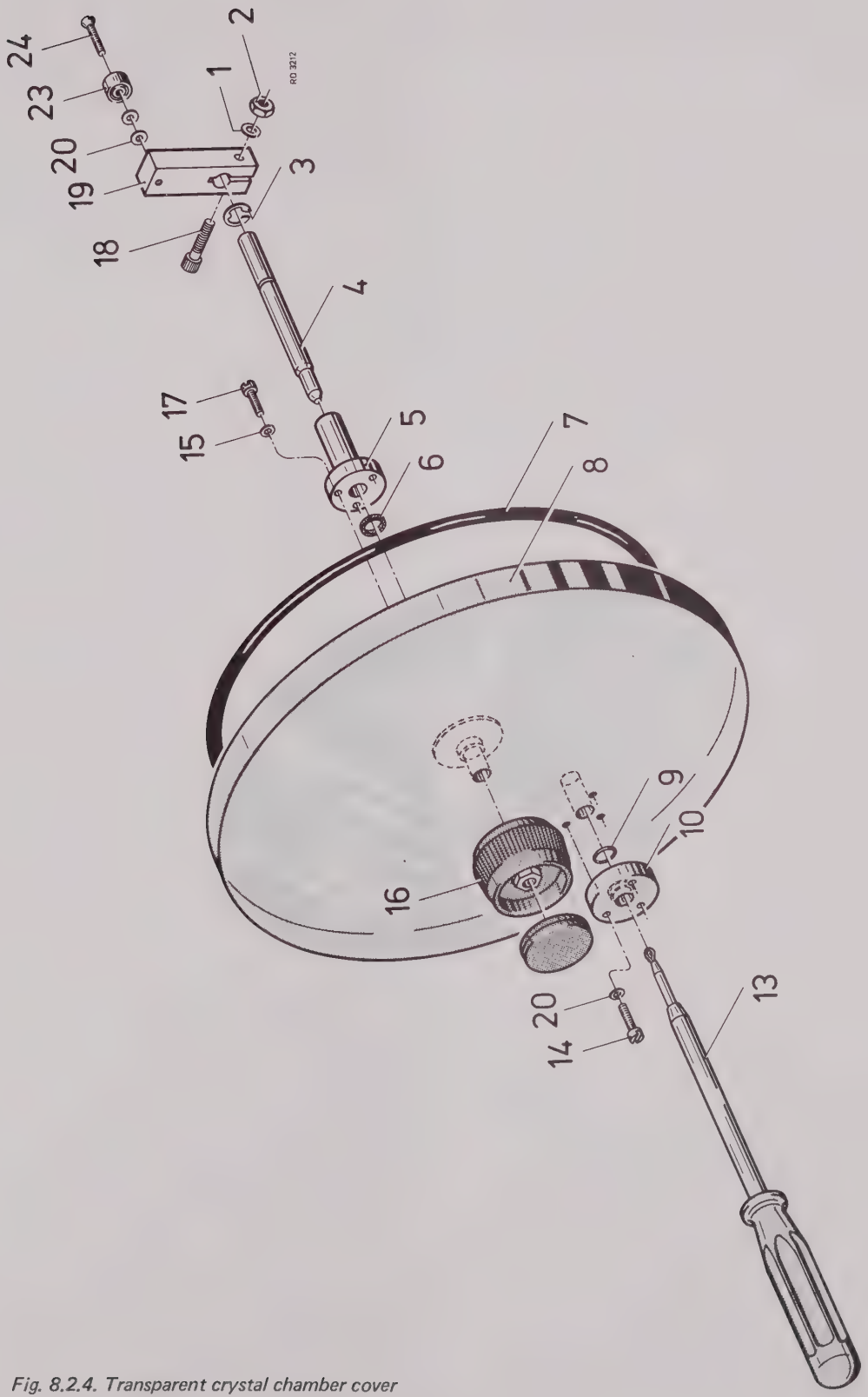

Fig. 8.2.4. Transparent crystal chamber cover

8.2.5. Crystal changer assembly

Item	*Description*	Ordering code 5322 694 14383 *Ordering code*
2	Spring hook plate	5322 405 94089
3	Extension spring 6 x 0,8 mm x 1 m (2,5 cm required)	5322 492 34437
5	Ball bearing single row 5 x 16 x 5 mm	5322 520 20225
28	Circlip external 3 mm	5322 530 74076
30	Ball bearing single row 3 x 10 x 4 mm	5322 520 20044
33	Circlip internal 10 mm	4822 530 70135
40	Adjusting screw	5322 502 14148
58	Blade spring set of 6	5322 694 14054
63	Anti-scalter strips set of 12	5322 694 14064
66	Compression spring	5322 492 54182
78	Shaft retaining strips set of 2	5322 694 14058
79	Blade springs set of 4	5322 694 14057

✳ FOR SERIAL NUMBERS DY601÷650
⊙ FOR SERIAL NUMBERS DY651 ONWARDS

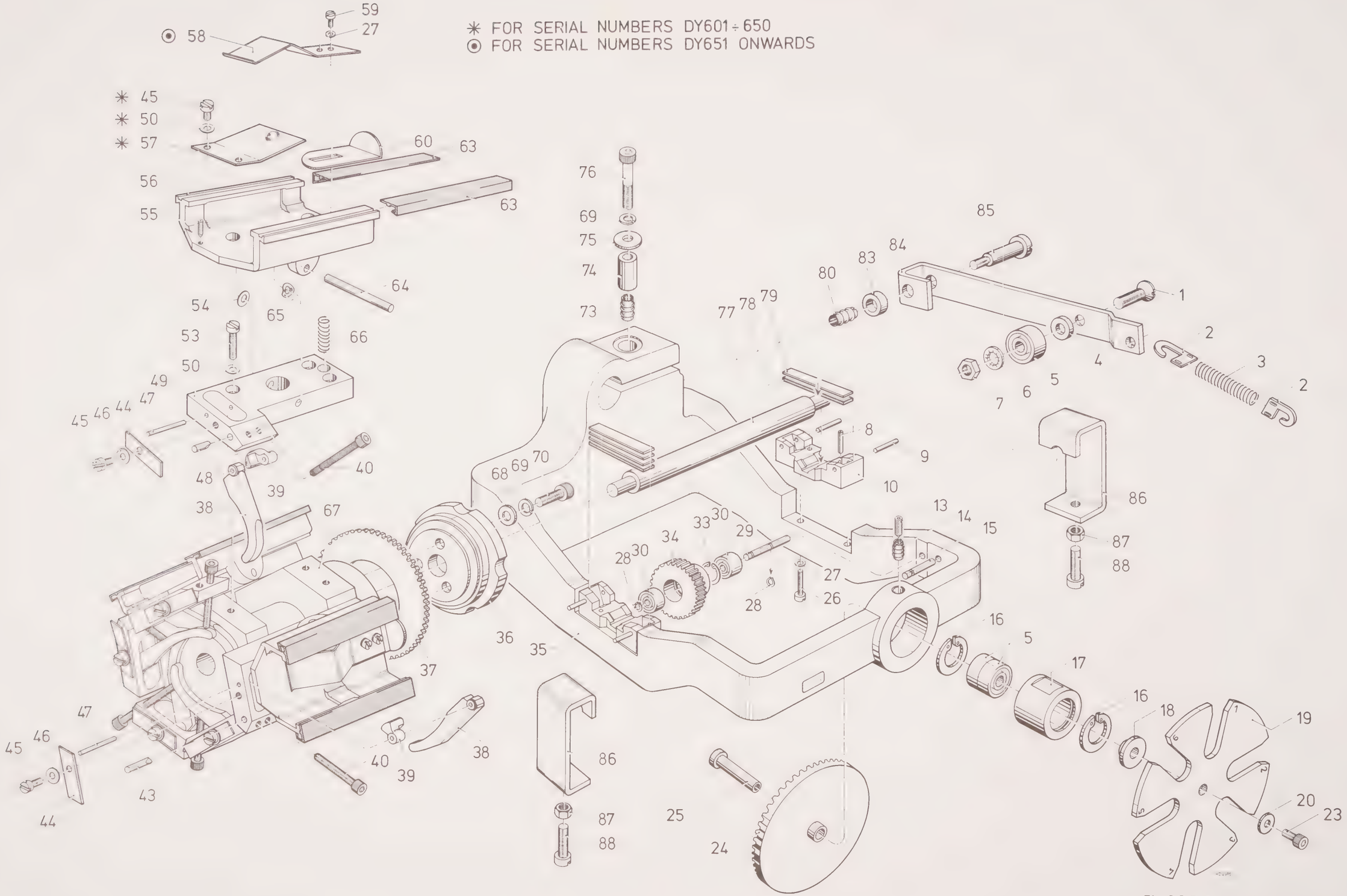

Fig. 8.2.5. Crystal changer assembly

8.2.6. Sample chamber

Item	*Description*	*Ordering code*
3	O-ring PRP142	5322 530 54093
4	O-ring eriks 2,62 x 120,32 mm	5322 530 54619
7	Release spring	5322 492 64657
22	Diafragm. 24 mm	5322 525 14013
	Diafragm. 28 mm	5322 525 14012
	Diafragm. 35 mm	5322 525 14011
31	Isolating ring	5322 532 54401
32	O-ring PRP224 3,53 x 44,0 mm	5322 530 54568
34	Spring dowel 1 x 6 mm	5322 529 50037
35	Bevel gear	5322 522 34765
36	Belville washer 4,2 mm	5322 530 84103
40	Dowel pin 2 x 8 mm	5322 535 14142
43	Ring PTFE	5322 532 54418
44	O-ring PRP007 1,78 x 3,68 mm	5322 530 54567
46	Shaft for diaphragm	5322 535 94874
48	Plain sleeve bearing 4 x 7 x 8 mm	5322 520 34202
49	Shaft for diaphragm drive	5322 535 94879
53	Microswitch	5322 271 34226
55	Drive spring	5322 492 64661
56	Drive arm	5322 405 74017
58	Shaft	5322 535 94885
59	Spacer 3,1 x 5 x 3 mm	5322 532 14642
60	Ball bearing double row sealed 3 x 10 x 4 mm	5322 520 20044
61	Hose connector 0,125 inch gas	5322 526 44169
66	Actuator M6020/25	5322 360 44059
67	Actuator M7020/25	5322 360 44061
79	Motor M3	5322 361 84208
80	Gearbox with pinion 1 : 16,66	5322 522 14081
	Gearbox with pinion 60 Hz 1 : 20	5322 522 14082
86	Drive coupling for spinner	5322 405 74015
87	Ball bearing, single row sealed 4 x 13 x 5 mm	5322 520 20087
88	Drive arm for spinner	5322 405 74014
89	Circlip internal 19 mm	4822 530 70018
90	Ball bearing single row sealed 5 x 19 x 6 mm	5322 520 20064
93	Circlip external 5 mm	5322 530 70225
94	Spinner shaft	5322 535 94881
97	Quadring 4008 4,47 x 1,78 mm	5322 532 54408
98	Support ring for quadring 4008	5322 532 54409

Item	*Description*	*Ordering code*
100-190	Airlock mechanism complete	5322 694 14381
108	Spring dowel 3 x 12 mm	5322 535 14148
110	Gearwheel 54 T	5322 522 34772
111	Quadring 1,78 x 6,07 mm	5322 530 54351
114	O-ring Gaco R4 1000	5322 530 54011
115	Shaft filter mechanism	5322 535 94884
116	Pressure pad M4	5322 462 50177
117	Aluminium filter assembly	5322 480 30084
119	Shaft for sample turret	5322 535 94883
120	Support ring for quadring 4111	5322 532 54419
123	Quadring 4111 10,77 x 2,62 mm	5322 532 54421
125	Ball bearing single row sealed 12 x 28 x 8 mm	5322 520 20157
126	Belville washer 21,8 x 12,3 x 0,35 mm	5322 530 80116
127	Gearwheel 54 T	5322 522 34769
128	Ball bearing single row 12 x 21 x 5 mm	5322 520 24146
130	Gearwheel 80 T	5322 522 34771
133	Retaining ring external 8 mm	4822 530 70128
134	Compression spring	5322 492 50741
135	Sample turret drive arm	5322 405 74018
140	Shaft	5322 535 94877
143	Ball bearing single row 4 x 13 x 5 mm	5322 520 20087
144	Retaining ring external 2,3 mm	4822 530 70043
147	Spring coupling ring	5322 532 14653
154	Operating spring with roller	5322 402 50032
167	Quadring MRC4110	5322 530 54339
168	Plain-sleeve bearing	5322 520 34201
170	O-ring Gaco RM039530	5322 530 54617
176	Quadring 4222	5322 466 64205
177	Shaft for airlock plunger (with piston)	5322 535 74559
179	Circlip internal 21 mm	5322 492 64668
180	Plain sleeve bearing	5322 532 64249
181	O-ring PRP010	5322 530 54618
183	Quadring 114 14,55 x 2,62 mm	5322 532 54424
185	O-ring Gaco R165	5322 530 54008
188	O-ring PRP 141	5322 530 54094
196	Microswitch assembly	5322 271 34225

Item	*Description*	*Ordering code*
197	Electromagnet coil	5322 281 64175
198, 207	Valve 2/2 way	5322 360 54067
199	Coupling M5	5322 526 44045
200	Threaded connector	5322 526 44154
204	Banjo coupling M5	5322 526 44111
206	Vacuum valve 5322 694 14946	5322 360 54062
208	Elbow coupling	5322 526 44014
209	Magnet 24 V DC Herion 0110	5322 281 64156
210	Air inlet valve Edwards 0,375 inch	5322 360 54082
215	Microswitch assy	5322 271 34223
216	Spring	5322 492 34626
218	Mask 24mm	5322 525 14013
	28mm	5322 525 14012
	35mm	5322 525 14011

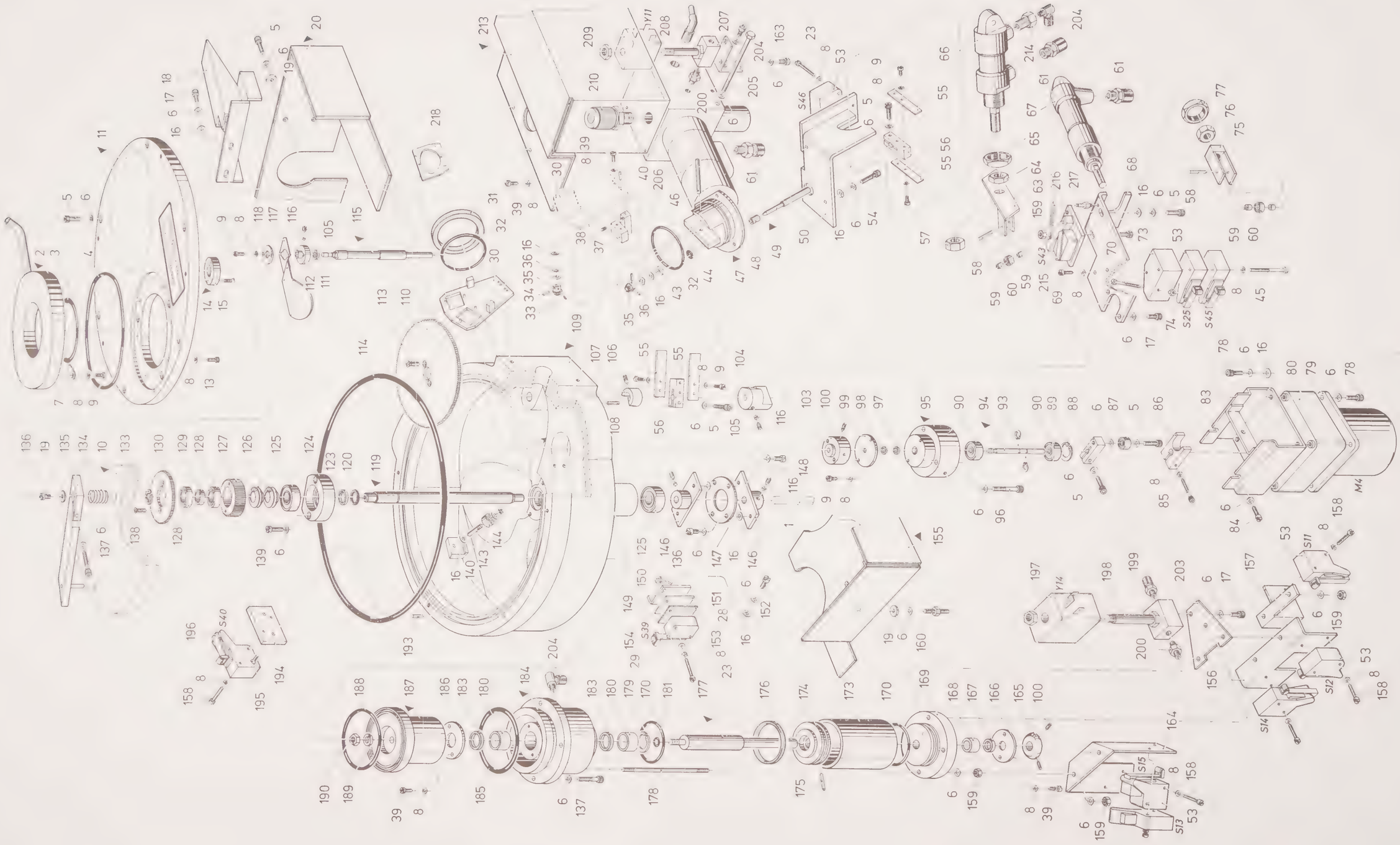

Fig. 8.2.6. Sample chamber

8.2.7. Sample turret

	Assy except item 4	Ordering code 5322 694 14382
Item	*Description*	*Ordering code*
5	Special grub screw	5322 502 14149
6	Adjustable carrier ring	5322 532 34111
7	Inner bearing ring	5322 532 24527
9	Curved washer	5322 530 84102
11-17	Bearing ring assy complete	5322 693 14009
13	Bearing pin	5322 535 94876
15	Bearing pin	5322 535 94875
16	Ball bearing 3 x 8 x 3 mm	5322 520 24195
17	Retaining ring external 1,9 mm	4822 530 70122
18	Ball bearing 3 x 7 x 2 mm	5322 520 24182
19	Tapered retaining ring	5322 532 24528
20	Gearwheel	5322 522 34773

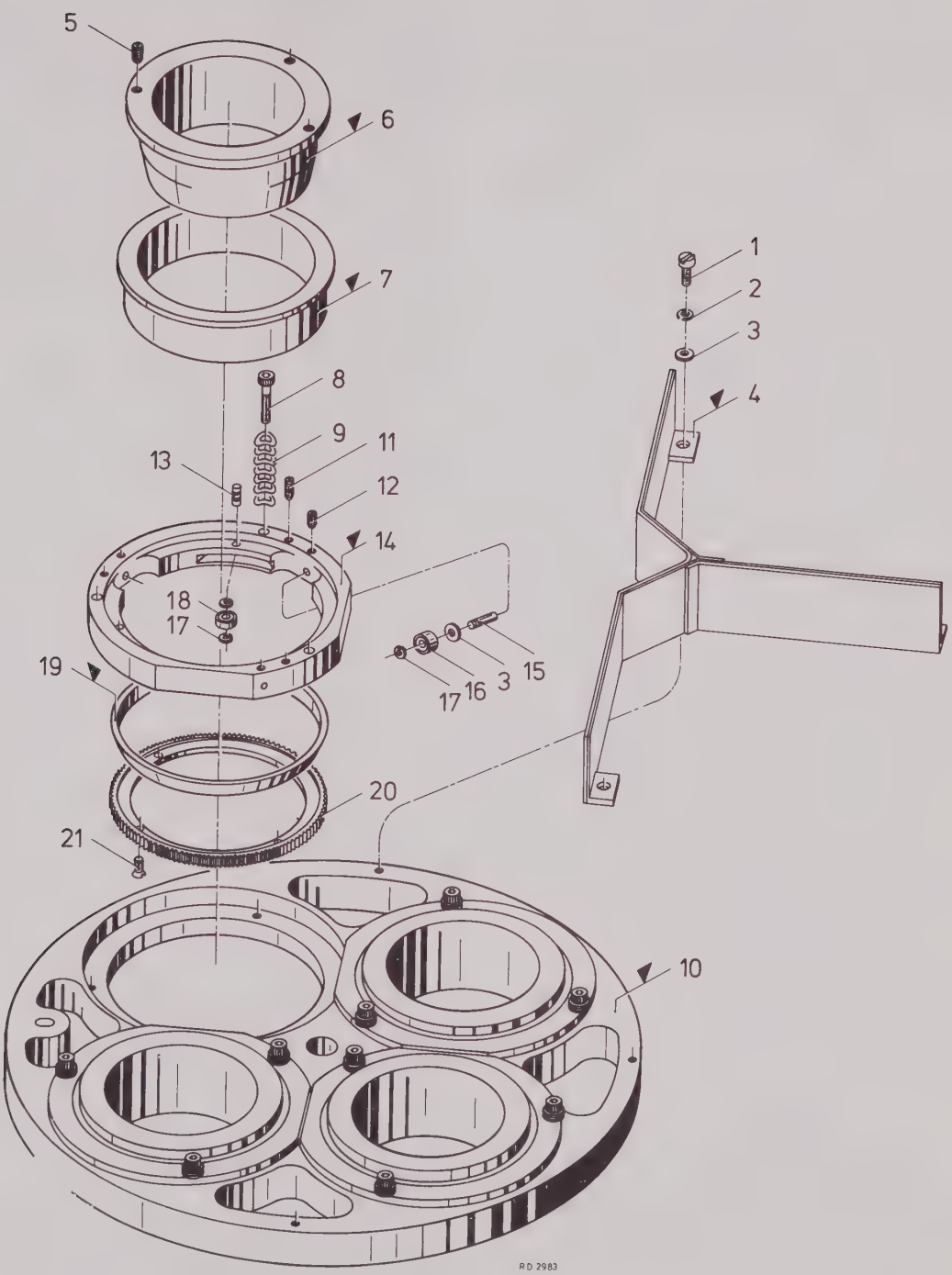

Fig. 8.2.7. Sample turret

8.2.8. Sample turret drive mechanism

Item	*Description*	*Ordering code*
1	Shaft	5322 535 94872
6	Pivot tube	5322 535 94873
8	Ball bearing single row 8 x 22 x 7 mm	5322 520 20226
13	Spring hook plate 10 mm	5322 405 94092
14	Extension spring 10 x 1,2 (4 ccm needed)	5322 492 34439
15	Microswitch assembly	5322 271 34226
18	Spring dowel 3 x 10 mm	5322 529 54029
19	Projective pressure PAD, M4	5322 462 50177
30	Ball bearing double row 8 x 22 x 7 mm	5322 520 20244
34	Spring dowel 3 x 20 mm	5322 529 50049
36	Slotted disc	5322 694 14028
38	Drive arm	5322 405 74016
46	Ball bearing single row 3 x 10 x 4 mm	5322 520 20044
50	Gearbox 25 : 1 10 rev/min	5322 522 14079
53	Synchronous motor 24 V, 50/60 Hz	5322 361 84208

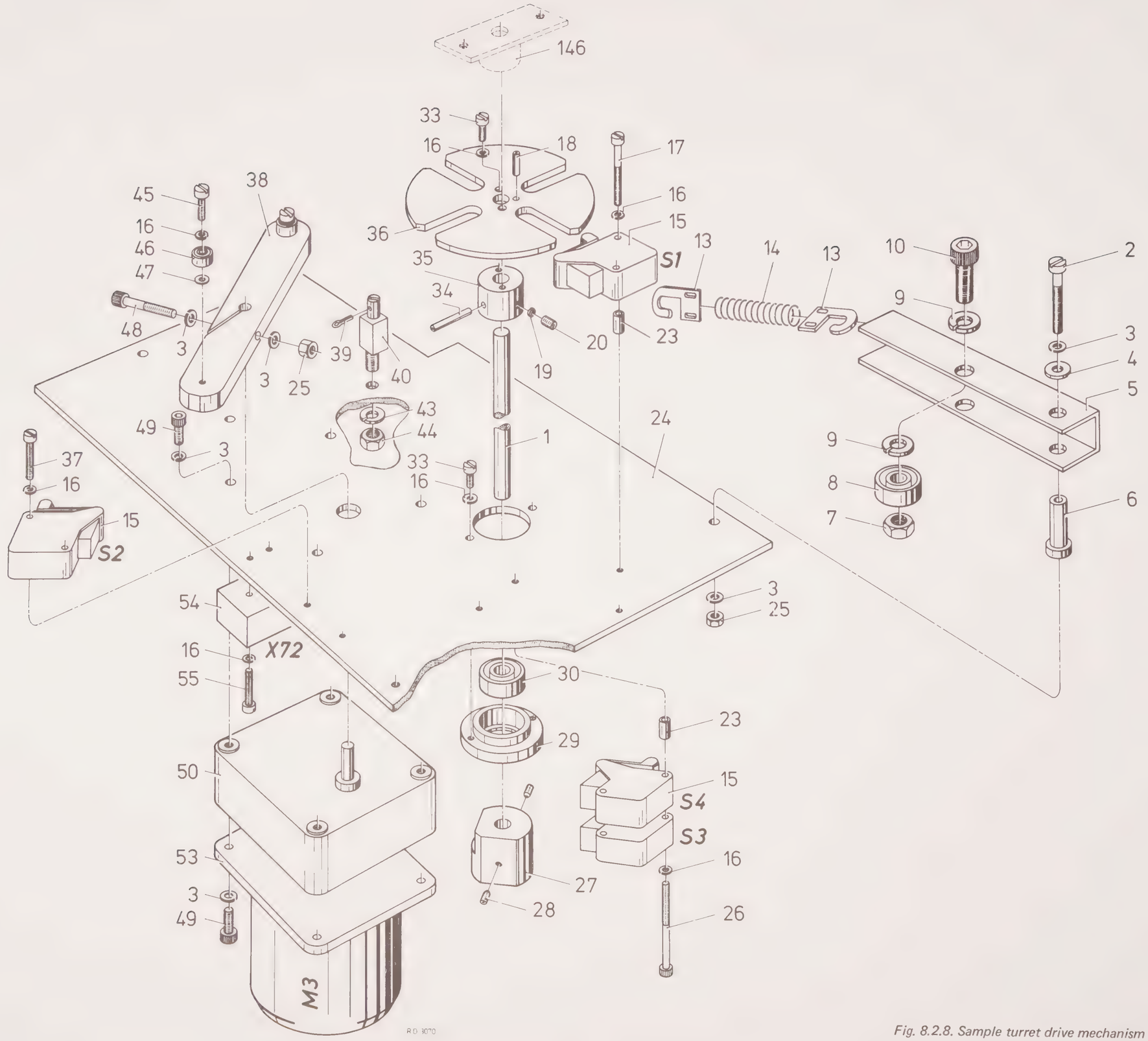

Fig. 8.2.8. Sample turret drive mechanism

8.2.9. Primary collimator

Ordering code
5322 529 44015

Item	*Description*	*Ordering code*
7	Wire ball bearing	5322 520 24147

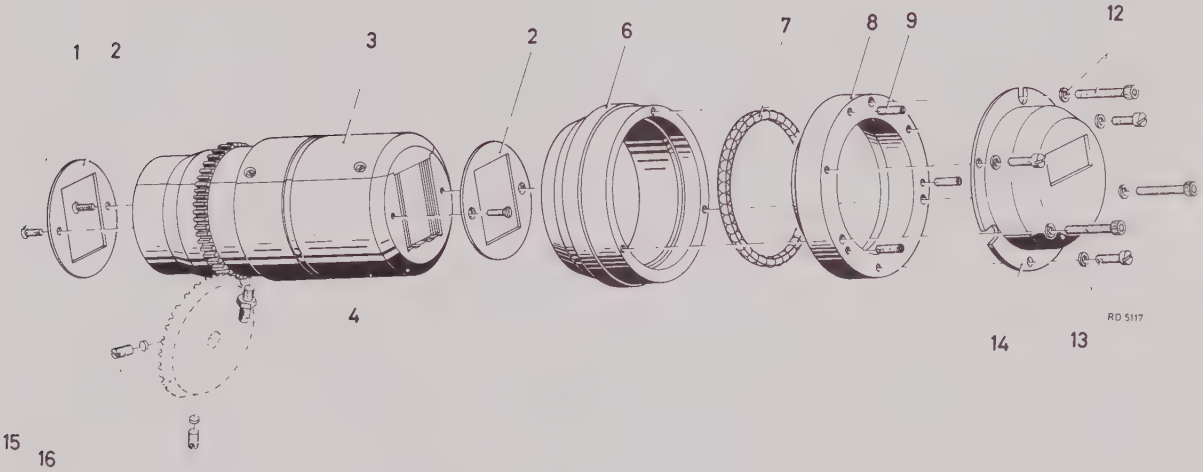

Fig. 8.2.9. Primary collimator

8.2.10. Cap unit mechanism

Item	*Description*	*Ordering code*
3	Microswitch assembly	5322 271 34226
7	Spring dowel 2 x 12	5322 529 54035
11	Connector block 15 pole X68	5322 265 44082
12	Locking strip 15-pole	5322 268 44136
15	External retaining ring 7 mm	4822 530 70127
16	Bearing block assy	5322 520 14275
19	O-ring Gaco R3275	5322 530 54335
27	Spring dowel 3 x 20 mm	5322 529 50049
30	Lever	5322 405 74013
35	Plain bearing	5322 532 24526
38	Adjustable linkage QM376	5322 405 74019
40	Air pressure cylinder Martonair M-6025-50	5322 360 44058
43	Cylinder anchorage L QM378	5322 417 14088
46	Hose nipple 0,125 inch gas (see also item 8)	5322 526 44176
50	Screw connector block 15-pole	5322 290 64152
57	Nipple 8 x 0,25 Serto SO-1600	5322 526 44156
59	O-ring Gaco R2093	5322 530 54521
60	Filter	5322 480 44007
61	Nipple 10 x 0,25 Serto SO-1600	5322 526 44155
64	Magnet 24 V DC Herion 0202	5322 281 64168
65	2/2 valve Herion 92020 00 0000	5322 360 54004
73	Adapter nipple 0,125 gas x M5 Herion 0657341	5322 526 44188
74	Magnet 24 V DC Herion 0110	5322 281 64156
75	2/2 valve Herion 02413 21 0000	5322 360 54067
76	Screw-in-filter M1511 0,125 inch	5322 502 14151
81	Quick release coupling U4 Couples hose to item 46	5322 526 44175

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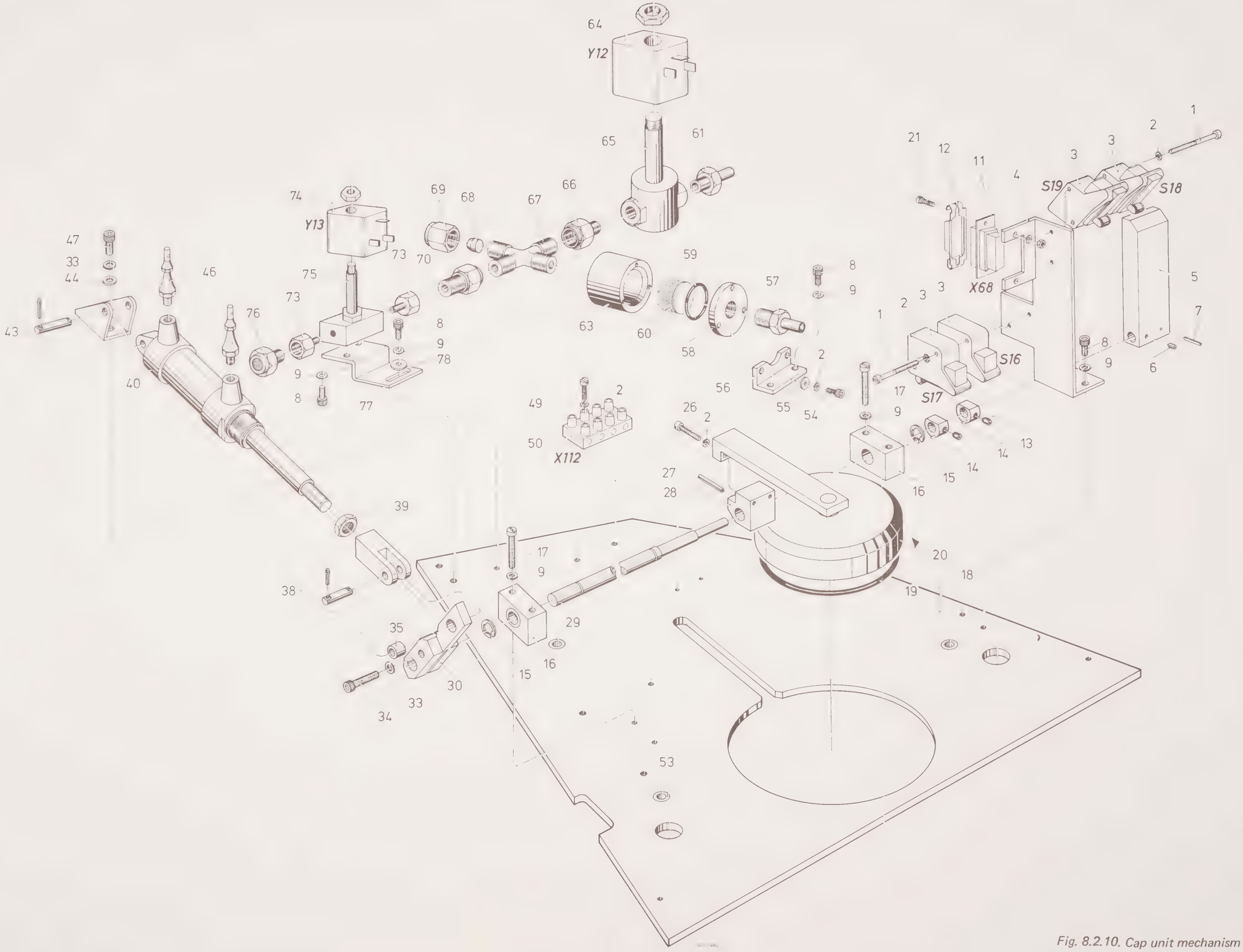


Fig. 8.2.10. Cap unit mechanism

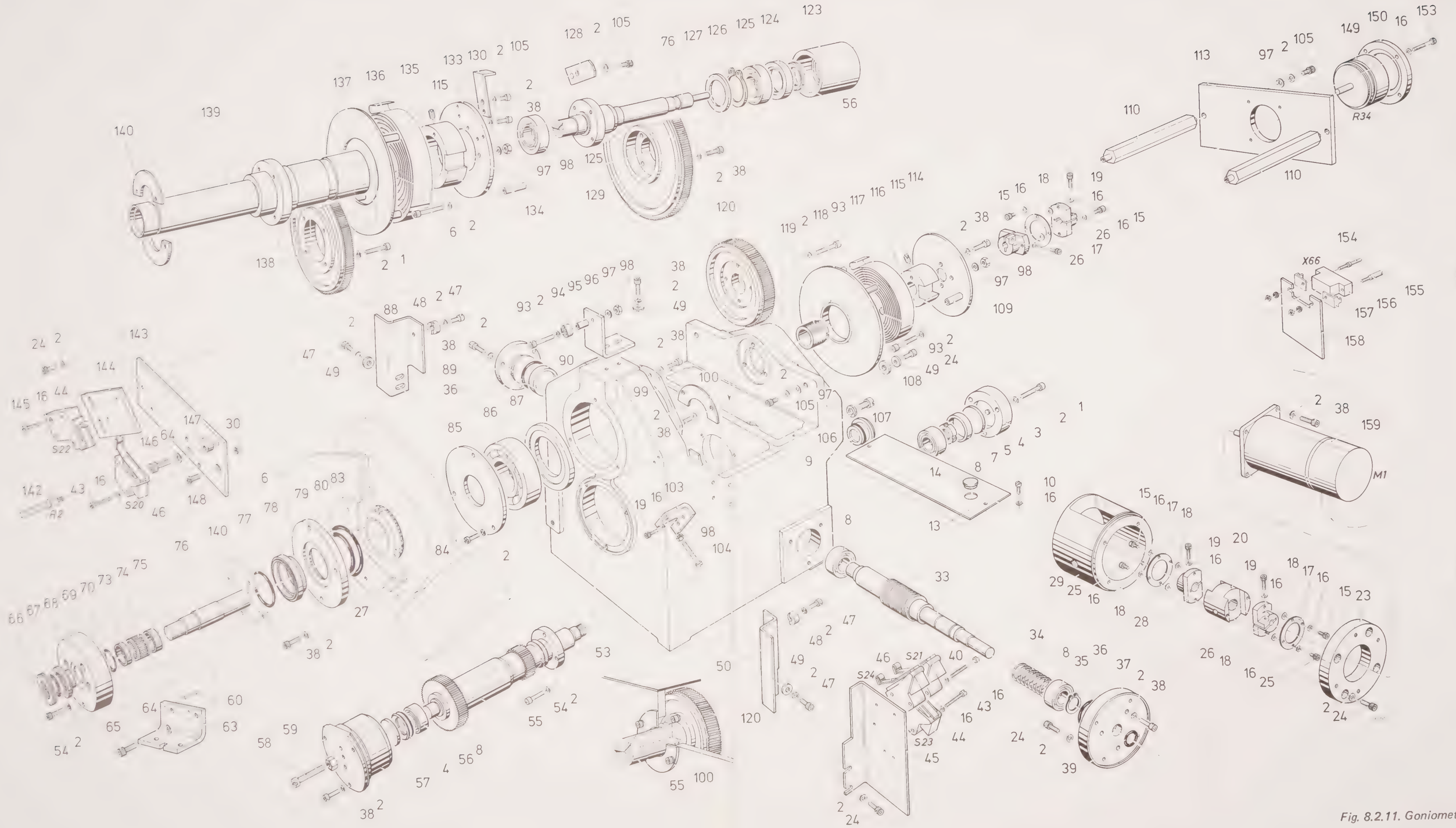


Fig. 8.2.11. Goniometer

8.2.11. Goniometer

Item	*Description*	*Ordering code*
8	Ball bearing 32 x 15 x 9 mm	5322 520 24193
9	Oil level sightglass	5322 530 30045
14	Oil filler plug	5322 414 74022
15 ... 20, 26, 28	Coupling complete	5322 694 14462
17	Spring coupling ring	5322 492 64658
26	Coupling piece	5322 466 85743
28	Coupling piece	5322 466 85742
33	Worm shaft	5322 535 94878
34	Compression spring	5322 492 54286
35	Circlip external 15 mm	4822 530 70033
36	O-ring Gaco R1406	5322 530 54569
39	O-ring REV-O-SLIP special	5322 530 54101
44	Microswitch assy	5322 271 34226
46	Microswitch assy	5322 271 34224
55, 129, 138	Shaft + gear wheels kit	5322 694 14461
66	Laminated washer	5322 532 14654
67	O-ring Gaco R3075	5322 530 54137
68	Sealing ring	5322 532 60489
70	O-ring REV-O-SLIP special	5322 530 54104
74	Needle bearing 19 x 23 x 13 mm	5322 520 20214
76	1 Theta shaft	5322 535 74558
77	O-ring Gaco R4143	5322 530 54163
78	Sealing ring	5322 532 60491
80	O-ring REV-O-SLIP special	5322 530 54103
83	O-ring Gaco R153	5322 530 54014
86	Ball bearing 72 x 35 x 17 mm	5322 520 24194
94	Ball bearing dust proof 4 x 13 x 5 mm	5322 520 20087
117	Torsion spring	5322 492 20016
120	Wormwheel	5322 522 34548
125	Ball bearing 19 x 40 x 9 mm	5322 520 24041
126	Circlip external 28 mm	5322 492 64666
136	Torsion spring	5322 492 24006
139	2 Theta shaft	5322 535 74561
142	NTC thermistor disc R2 15 k 5 % 0,5 W	5322 116 34031
149	Precision pot. meter sin Theta R34 Bourns 6574N-665-102	5322 103 64038
159	Stepping motor assy M1	5322 694 14509

8.2.12. Detector arm

Item	*Description*	*Ordering code*
3	Decoupling plate assembly	5322 466 85699
5	Ball bearing dust proof 3 x 10 x 4 mm set	5322 520 20044
43	Wire ball bearing	5322 520 20173
46	Blade spring	5322 492 64632
48	Blade spring	5322 492 64633
58	Eccentric bush	5322 532 24388
65	Blade spring	5322 492 61412
67	Ball bearing dust proof 4 x 13 x 5 mm	5322 520 20087

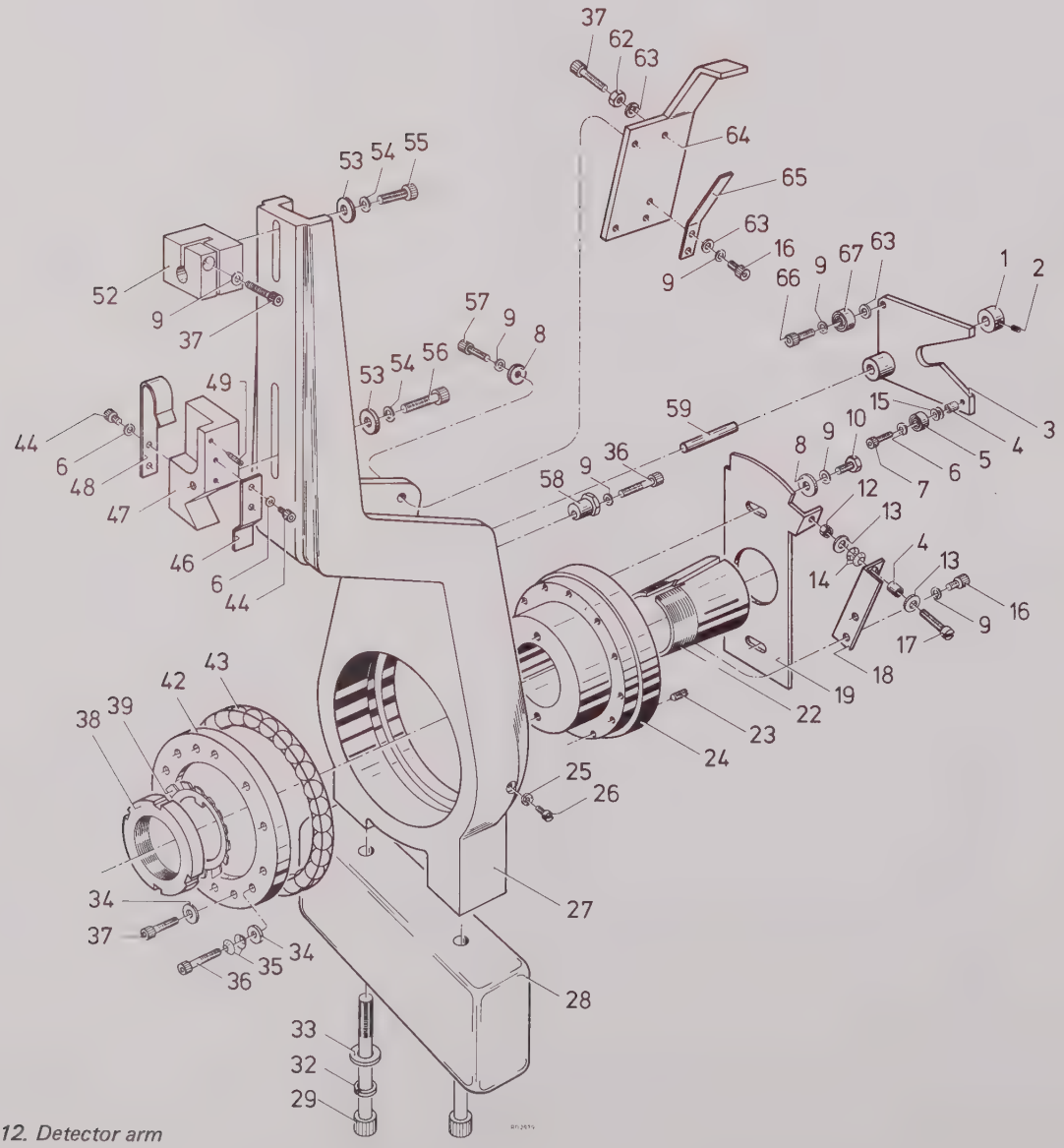


Fig. 8.2.12. Detector arm

8.2.13. Detector gas system

Item	*Description*	*Ordering code*
1	Copper tube 3 x 0,5 mm x 4 meter	5322 530 44018
2	Bulkhead union 4 x 5	5322 526 44017
3	Support union 4 x 3	5322 532 24346
4	Straight union	5322 526 44158
5	Hose fluorrubber 6 x 2,8 per meter	5322 530 20287
6	Clamping spring	5322 492 40404
7	Needle valve	5322 360 54063
8	Flow meter tube	5322 530 34047
9	Hose PVC 10 x 7 per meter	5322 530 20236
10	Adapter piece	5322 532 34109
	Flow detector compl.	5322 694 14394

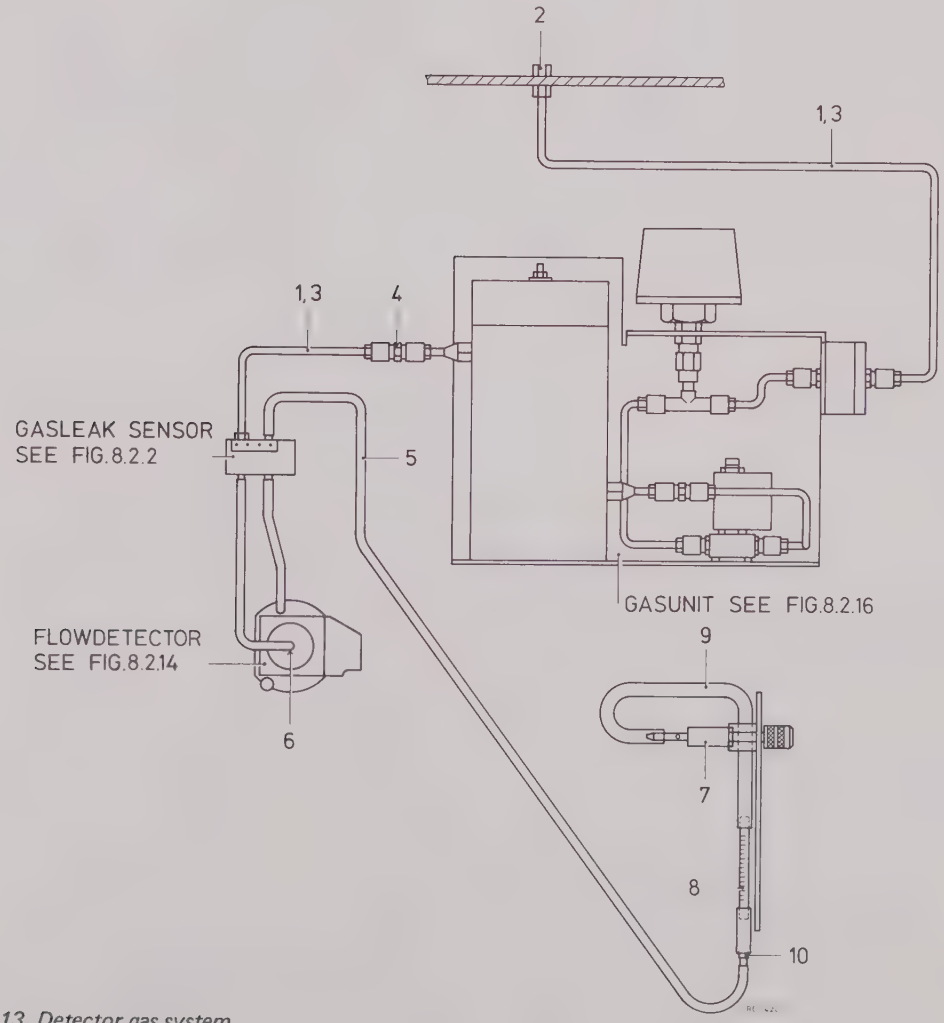


Fig. 8.2.13. Detector gas system

8.2.14. Gas flow detector

	Complete	Ordering code 5322 694 14394
Item	*Description*	*Ordering code*
1	O-ring SOR 133 22,1 x 1,6 mm	5322 530 54003
2	Magno nickel wire 10 m + 10 conical pins	5322 694 14384
3	Set of insulator discs	5322 694 14008
5	O-ring SOR 14 29,5 x 3 mm	5322 530 50521
12	Collimator complete	5322 529 44001
13	O-ring Buna 44 12 x 2,62 mm	5322 530 54148
27	Fluor rubber hose 8 x 12 mm per meter	5322 530 20291
33	O-ring SOR133 22,1x1,6mm.	5322 530 54003
37	Contact spring	5322 492 50801
38	O-ring Buna 2,9 x 1,78	5322 530 54114
40	Berylium window	5322 694 14296
47	Fluor rubber hose 6,0 x 2,8 mm	5322 530 20287

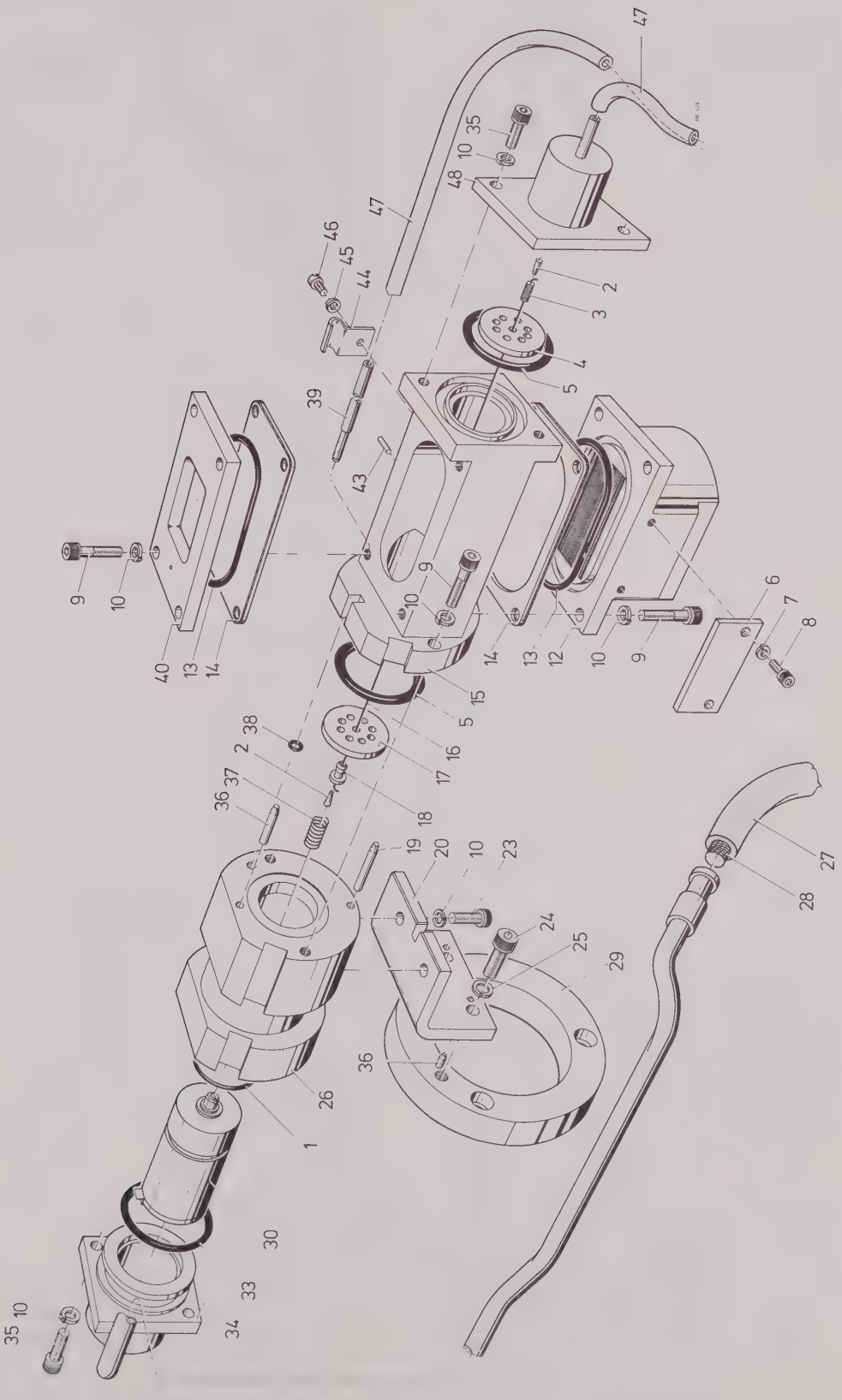


Fig. 8.2.14. Gas flow detector

8.2.15. Thin film charge amflifier

	Complete				Ordering code 5322 694 14393
Item	*Description*				*Ordering code*
C1	Capacitor	100 pF	5 %	2500 V	5322 122 34056
R1	Resistor	10 M	10 %	CR25	5322 110 63214
R1	Resistor	100 E	10 %	CR25	5322 110 63081
U1	Thin film circuit Charge amplifier OM 519				5322 209 86037
2	O-ring Buna 1,78x2,9				5322 530 34049

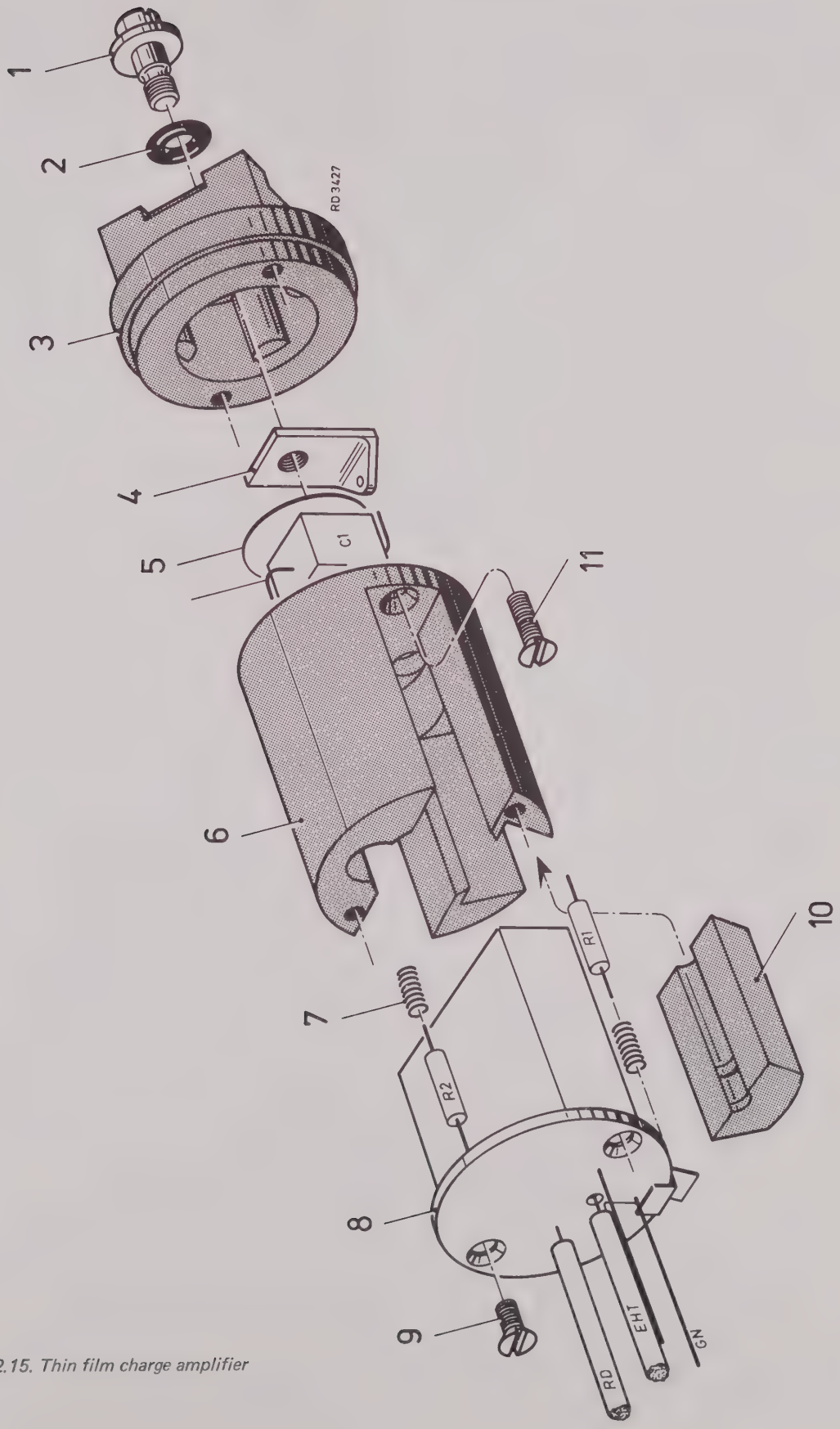


Fig. 8.2.15. Thin film charge amplifier

8.2.16. Gas unit assembly

Item	*Description*	*Ordering code*
1	Straight end union 4 x 0.125 gas Serto SO-1121	5322 526 44153
5	O-ring Gaco R2087	5322 530 54127
7	Filter support disc, sheet of 44	5322 466 85371
8	Filter disc 25 x 0.2 mm Millipore AANG 02500	5322 480 40042
15	Tube CU oxygen free 4 x 3 x 4 meter	5322 530 44018
16 + 17	Union nipple 4 x 0.125 inch gas Serto SO-21	5322 526 44019
34	Union support 4 x 3 Serto SO-3	5322 532 24346
18	Adjustable tee union MS6 Serto SO-3621-6-A-6	5322 526 44171
19	Bulkhead union 4 x 4 Serto SO-1528	5322 526 44191
23	Push button switch Klockner-Moeller MCS4	5322 276 14339
25	Electromagnet 24 V DC Herion 0110	5322 281 64156
26	Union nipple Herion 5 x 1/8" G	5322 526 44188
27	2/2 way valve Herion 09279-00-0000	5322 360 54067
28	Straight end union 4 x 1/8" G Serto SO-1121	5322 526 44153
33	Straight union 4 x 4 Serto SO-1021	5322 526 44158
12	See Gas density stabiliser	

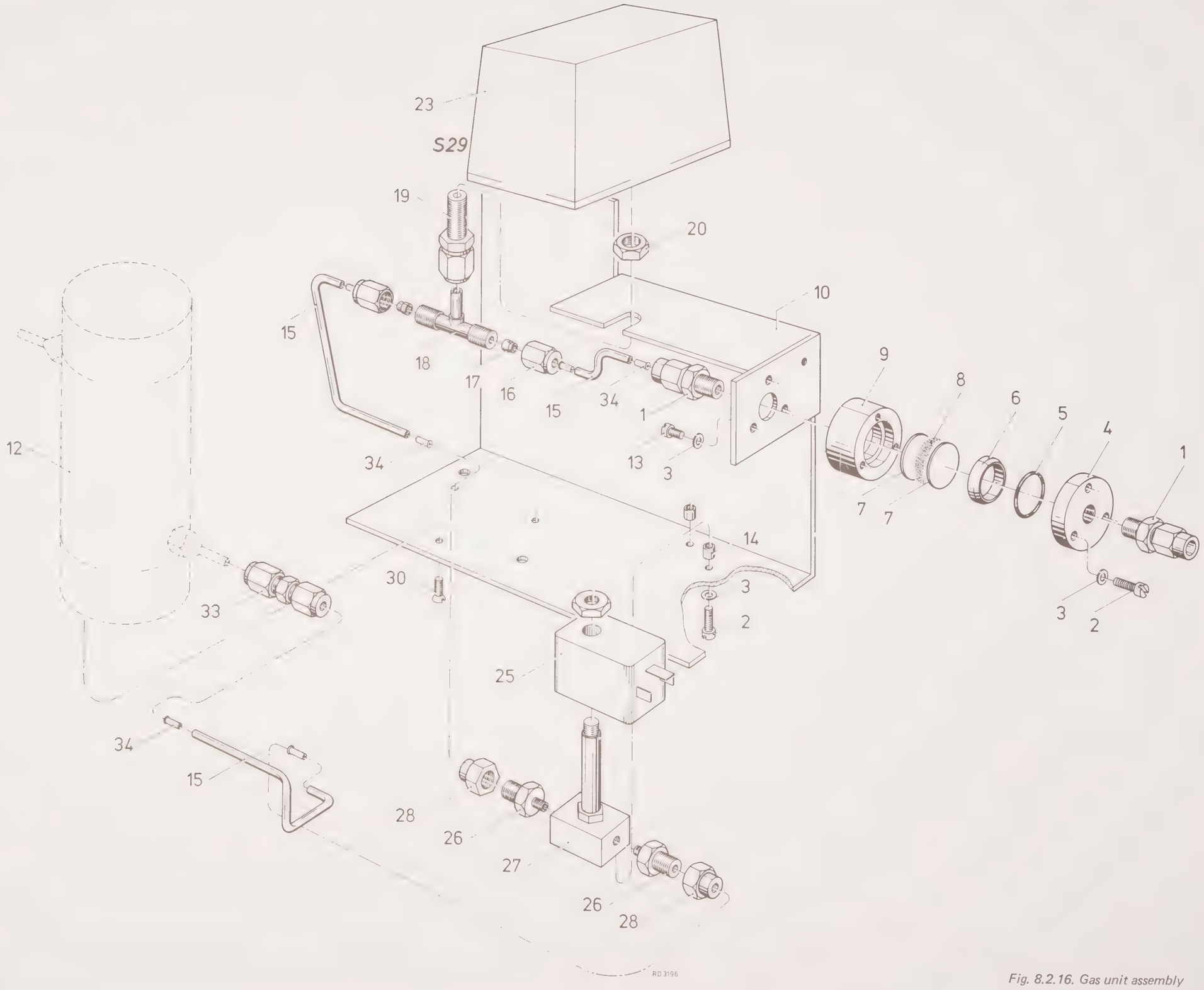


Fig. 8.2.16. Gas unit assembly

8.2.17. Gas density stabilizer

Ordering code
5322 694 14066

Item	*Description*	*Ordering code*
7	Valve seat	5322 694 14067
8	O-ring Gaco R2031	5322 530 54119
9	O-ring Gaco R3200	5322 530 50494
10	Hose coupling	5322 694 14069
11	O-ring Gaco R2018	5322 530 54116
19	Pressure pad M4	5322 462 50177
22	Bellows assembly	5322 694 14068
27	Ball bearing single row 3 x 10 x 4	5322 520 20014
31	Conical pin	5322 535 90171

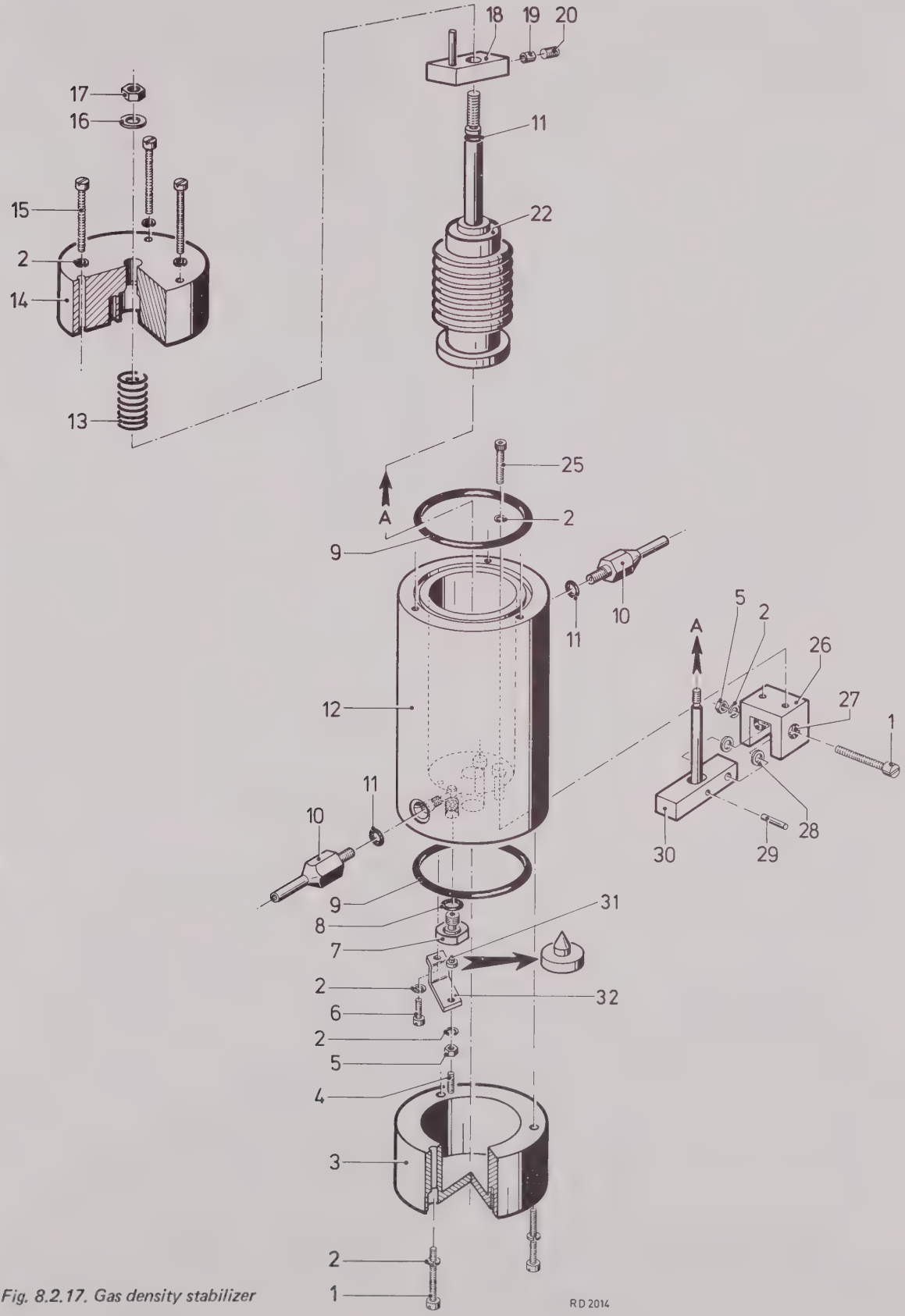


Fig. 8.2.17. Gas density stabilizer

8.2.18. Vacuum system

Item	*Description*	*Ordering code*
1	Vacuum pump complete with 50/60 Hz motor	4022 332 29970
2	Shock absorber blue	5322 529 10129
3	Shock absorber yellow	5322 529 10131
4	Shock absorber green	5322 529 10132
5	Aluminium oxide pellets	5322 390 84003
6	Vacuum hose assembly 38 x 25,5 x 470 with spring	5322 530 24092
7	Vacuum hose assembly 38 x 25,5 x 750 with spring	5322 530 24093
8	Vacuum hose chloroprene rubber 18 x 8 x 1,8 meter	5322 530 24096
9	Hose coupling 0,5 inch gas internal thread	5322 526 44181
10	Hose coupling 0,5 inch gas external thread	5322 526 44144
11	Hose PVC 19 x 13 per meter	5322 530 24097
12	Hose PVC 10 x 7 per meter	5322 530 20236
	Hose Neoprene 11 x 5 per meter	5322 530 24052

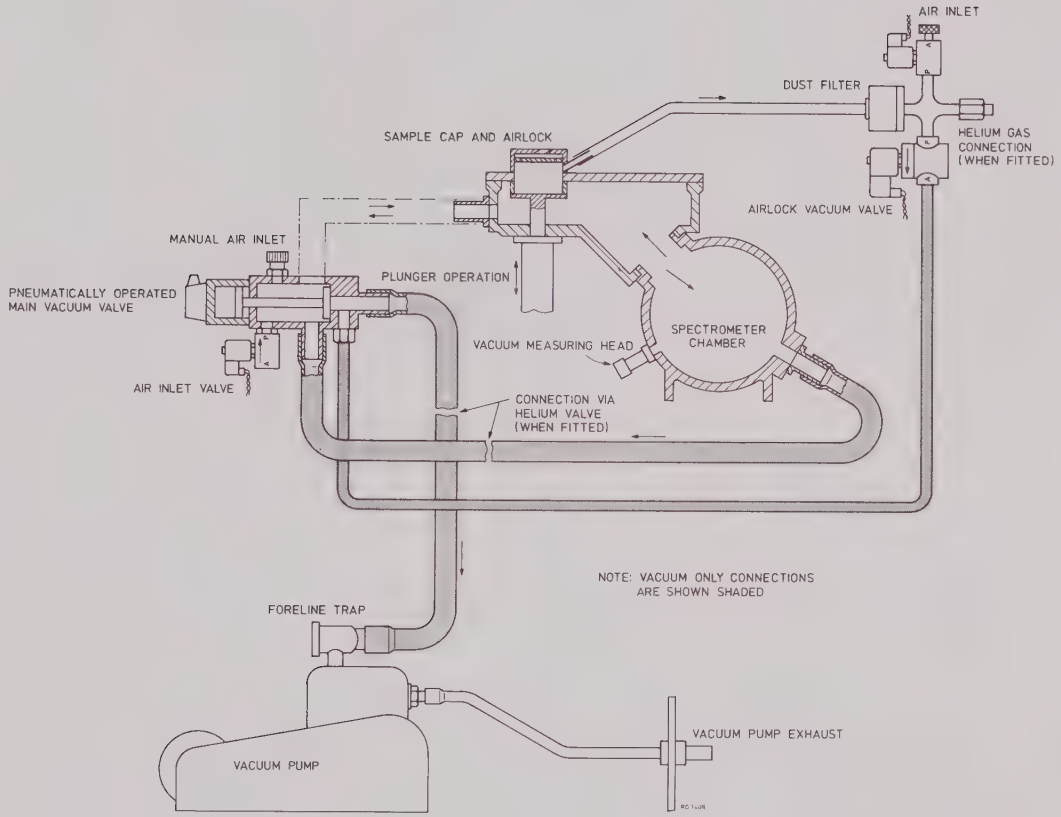


Fig. 8.2.18. Vacuum system

8.2.19. Pneumatic system

Item	*Description*	*Ordering code*
1	Adjustable tee-piece	5322 526 44151
2	Bulkhead union 8 x 0,25 inch Serto SO-1521	5322 526 44165
3	Sealing plug 8 Serto SO-2	5322 526 44179
4	Union nipple external 0,25 x 0,25 inch Serto SO-30	5322 526 44174
5	Sliencer 0,25 inch	5322 418 34029
6	Support union 8 x 6 Serto SO-3	5322 532 24513
7	Nylon hose 8 x 6 per meter	5322 530 24094

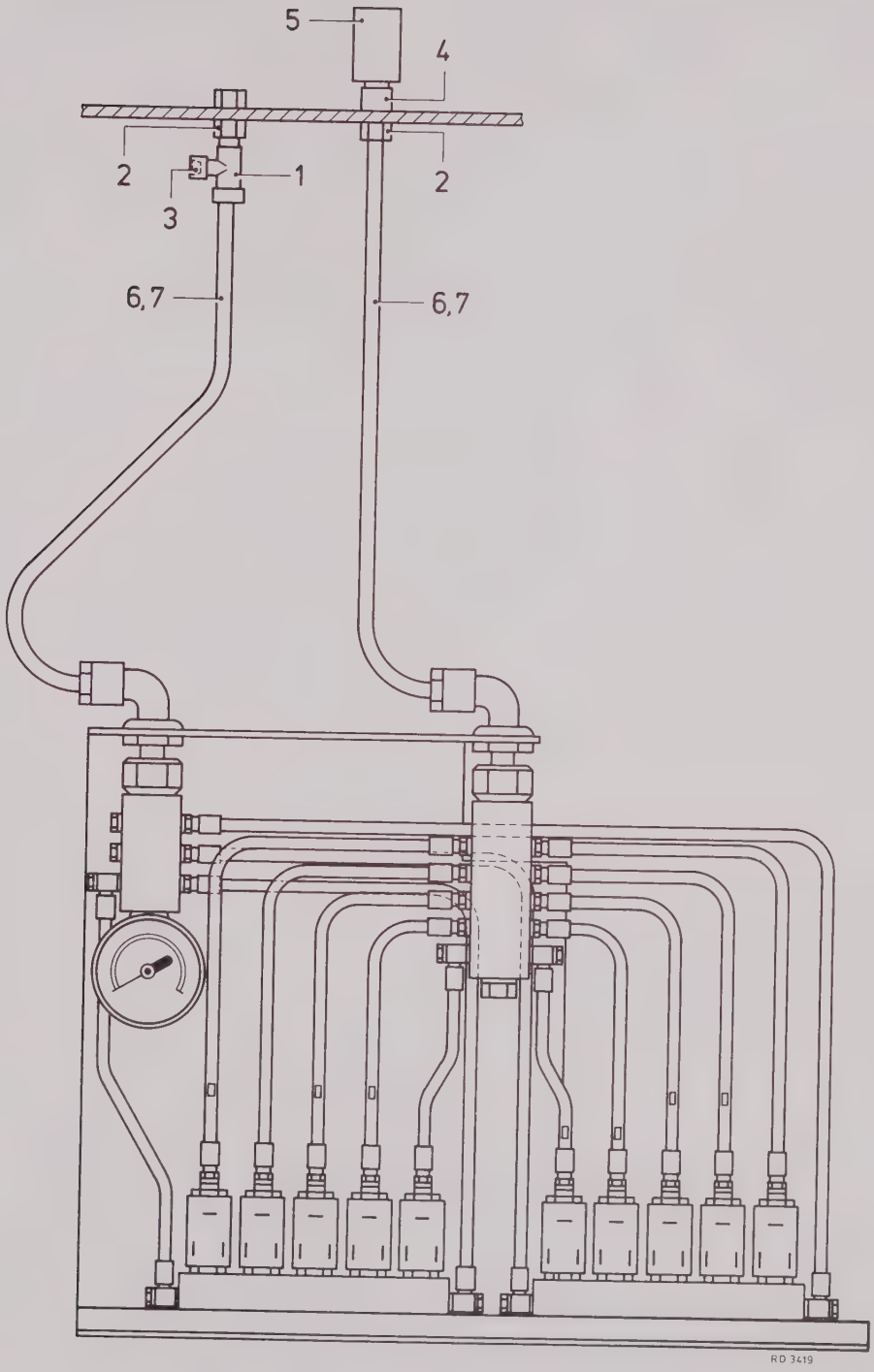
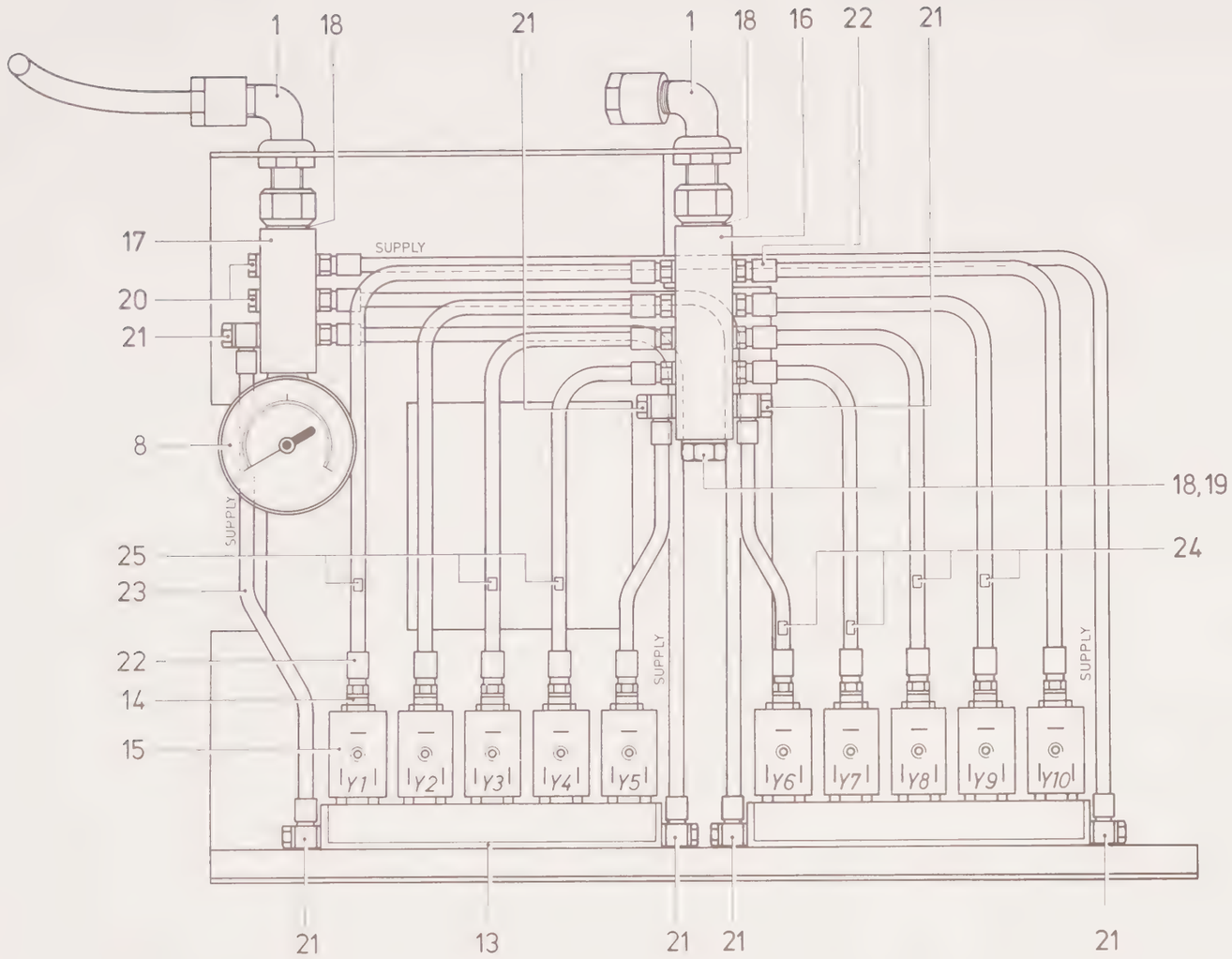
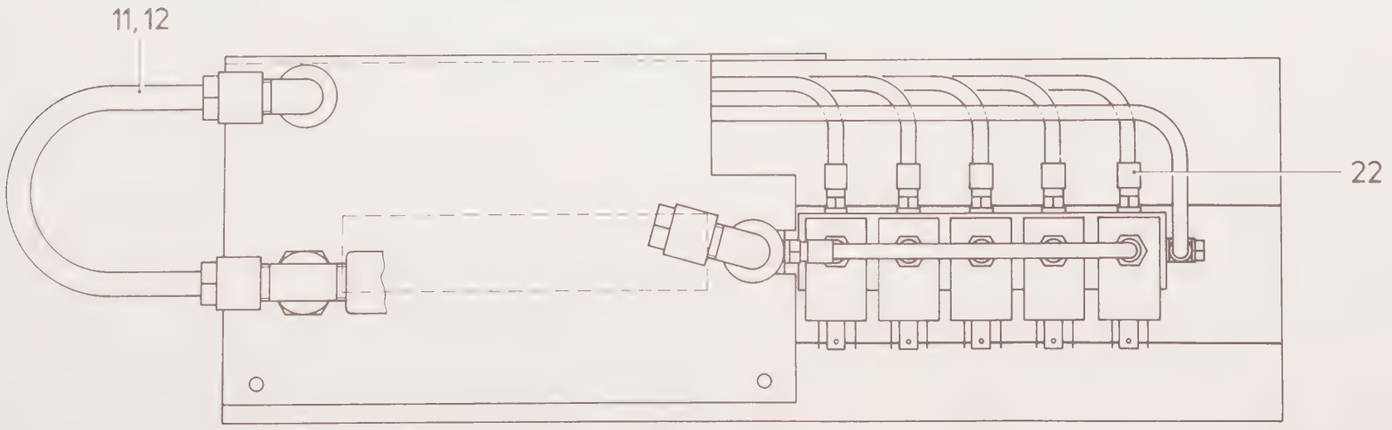


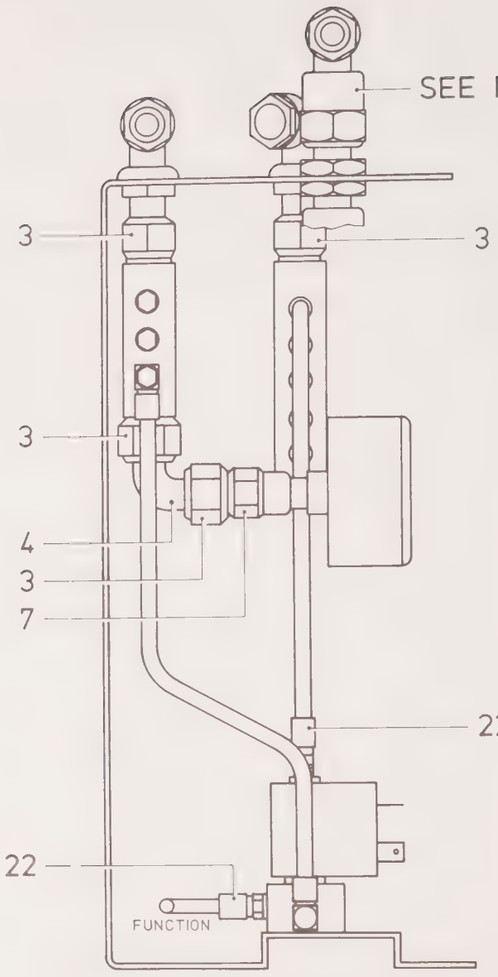
Fig. 8.2.19. Pneumatic system

8.2.20. Pneumatic unit

Item	*Description*	*Ordering code*
1	Bulkhead elbow coupling 8 x 5 Serto SO-2721	5322 526 44167
2	Bulkhead coupling 8 x 0,25 inch Serto SO-1521	5322 526 44165
3	Nipple 0,25 gas x 0,125 Serto SO-40	5322 526 44172
4	Elbow coupling 0,25 gas Serto SO-2421	5322 526 44157
5	Union nipple external 0,25 x 0,25 inch Serto SO-30	5322 526 44174
6	Tee union 0,25 inch gas Serto SO-3721	5322 526 44164
7	Union nipple external 6 x 0,125 inch Serto SO-30	5322 526 44173
8	Pressure gauge	5322 395 84065
9	Pressure switch	5322 278 94076
10	Pressure relief valve	5322 281 24027
11	Hose nylon 8 x 1 per meter	5322 530 24094
12	Union support Serto SO-3	5322 532 24513
13	Manifold for 5 valves Herion 0574827	5322 526 44185
14	3/2 way valve Herion 93407-21-00000	5322 281 24015
15	Electromagnet 24 V Herion 0110	5322 281 64156
16	Manifold Kuhnke 50-224	5322 526 44178
17	Manifold Kuhnke 50-222	5322 526 44177
18	Sealing washer 10 x 13 x 1,5 Kuhnke 50-010	5322 532 54388
19	Sealing plug 0,125 inch Kuhnke 50-501	5322 526 44184
20	Sealing plug M5 Kuhnke 50-500	5322 526 44046
21	Banjo union M5 Kuhnke 50-191	5322 526 44111
22	Hose connector Kuhnke 50-021	5322 526 44045
23	Hose nylon 4 x 6 per meter	5322 530 24095
24	Restriction piece 0,3	5322 532 24531
25	Restriction piece 0,5	5322 532 24529







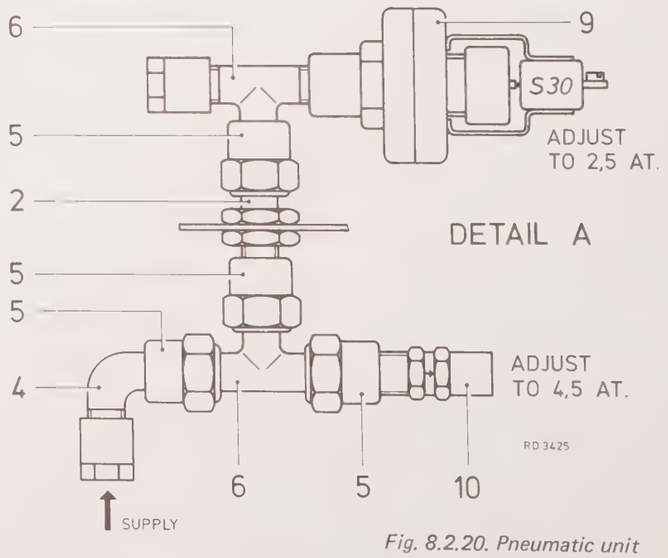


Fig. 8.2.20. Pneumatic unit

8.2.21. Water circuit

Item	*Description*	*Ordering code*
3	Union nipple int. 10 x 0,5 inch gas Serto SO-21	5322 505 14271
4	Bulkhead union 12 x 5 Serto SO-1521	5322 526 44166
5	Hose coupling 12 x 0,175 inch	5322 526 44183
6	Bulkhead adapter union 12 x 10 x 5	5322 526 44189
7	Hose coupling	5322 532 24517
8	Hose clip 13 x 20	4822 401 10492
9	Hose PVC 3 x 9 per meter	5322 530 24101
13	Elbow union 12 Serto SO-2021	5322 526 44168
14	Straight reduction union	5322 526 44159
20	Cupro Nickle pipe	
21	" " "	
22	" " "	
23	" " "	
24	" " "	
25	" " "	
26	Pipe olive S01-12mm.	
27	End union S021-12/½"	

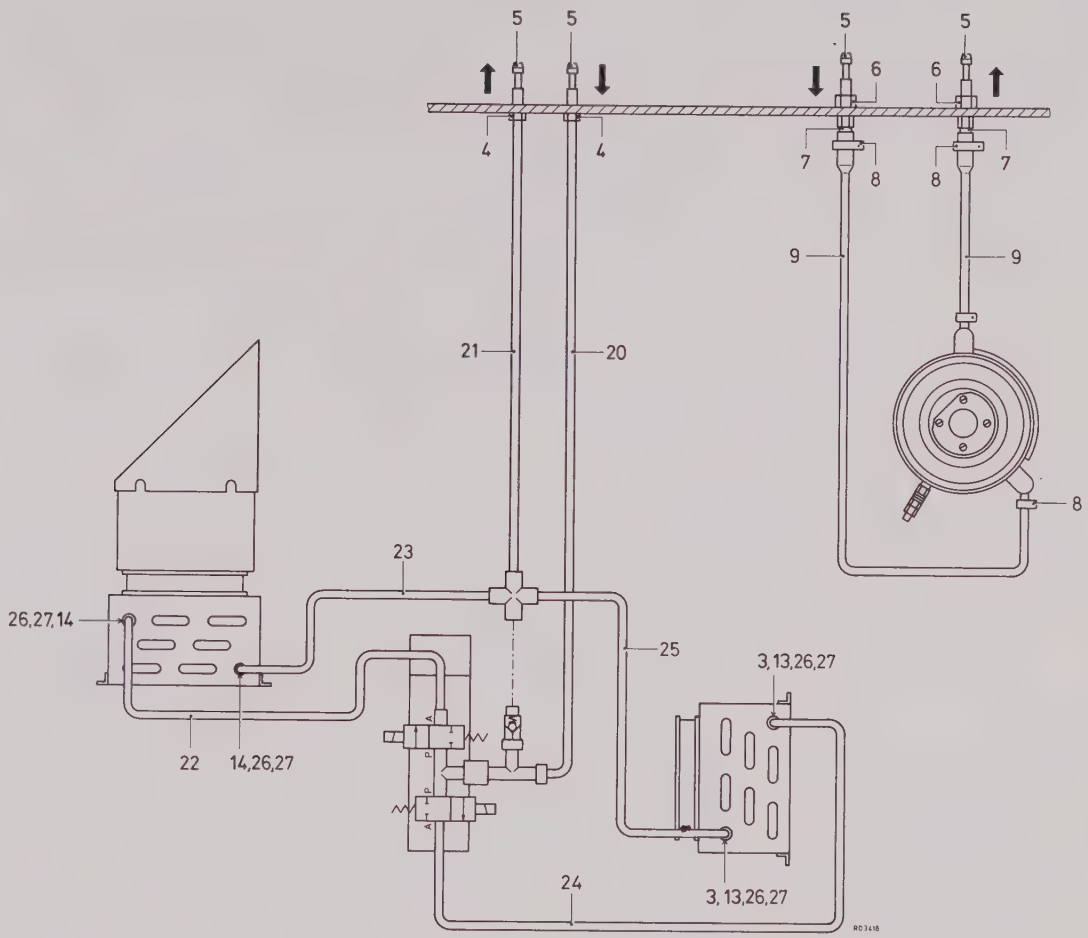


Fig. 8.2.21. Water system

8.2.22. Water valve unit (fig. 8.2.22)

Item	*Description*	*Ordering code*
9	Regulating valve	5322 360 54066
10	Electromagnet 24 V DC Herion 0702	5322 281 54046
11	2/2 way valve 10 mm x 0,375 inch	5322 360 54064
12	Tee union 10 x 12 x 10 Serto SO-3021	5322 526 44163
13	Elbow union 10 x 0,375 inch Serto SO-2421	5322 526 44095
14	Regulating valve	5322 360 54065

Water valve unit (fig. 8.2.22A)

Item	*Description*	*Ordering code*
3	End union 12 x 3/8" GK SO-1121 Serto	5322 526 44225
5	Tee-union G3/8"–3/8"–3/8" SO-3021 Serto	5322 526 44229
6	Nipple union 3/8" x 3/8" SO-30 Serto	5322 526 44226
7	Tee-union 3/8" x 3/8" x 1/2" G SO-3021 Serto	5322 526 44228
8	Nipple union 12 x 1/2" G SO-21 Serto	5322 526 44223
9	Nipple union 1/2" x 3/8" SO-30 Serto	5322 526 44227
10	Relief valve 5,7 PSI	5322 360 54083
11	Cross union 1/2" + Nipple 3/8" x 1/2" NPT SO-40 Serto	5322 526 44231

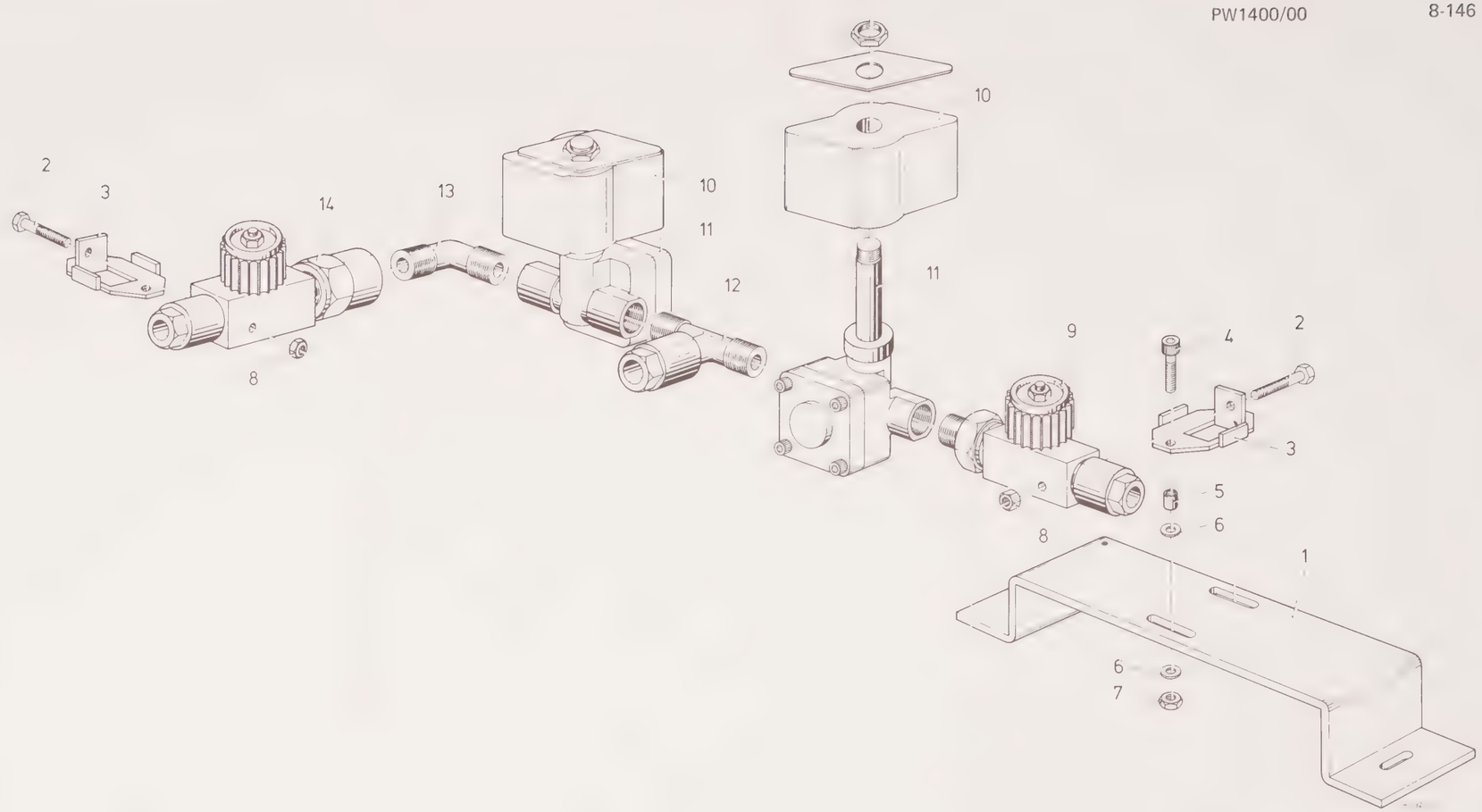


Fig. 8.2.22. Water valve unit

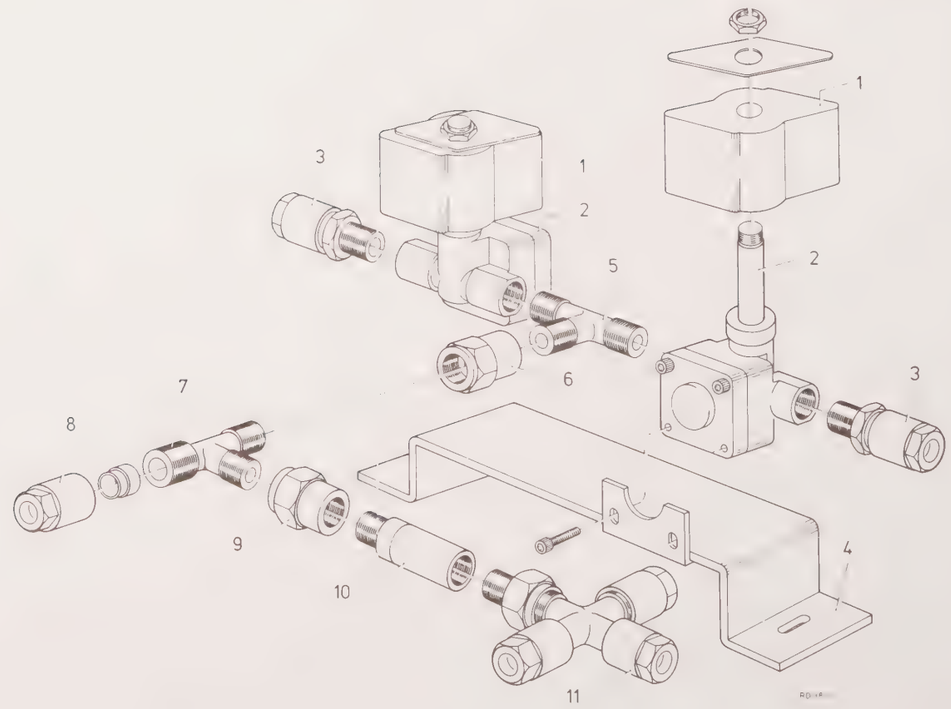


Fig. 8.2.22a

8.2.23. Cooler assembly

Item	*Description*	*Ordering code*
4	Fan M5, M6	5322 361 14148
7-15	Cooler assy (complete with water connections)	5322 694 14533

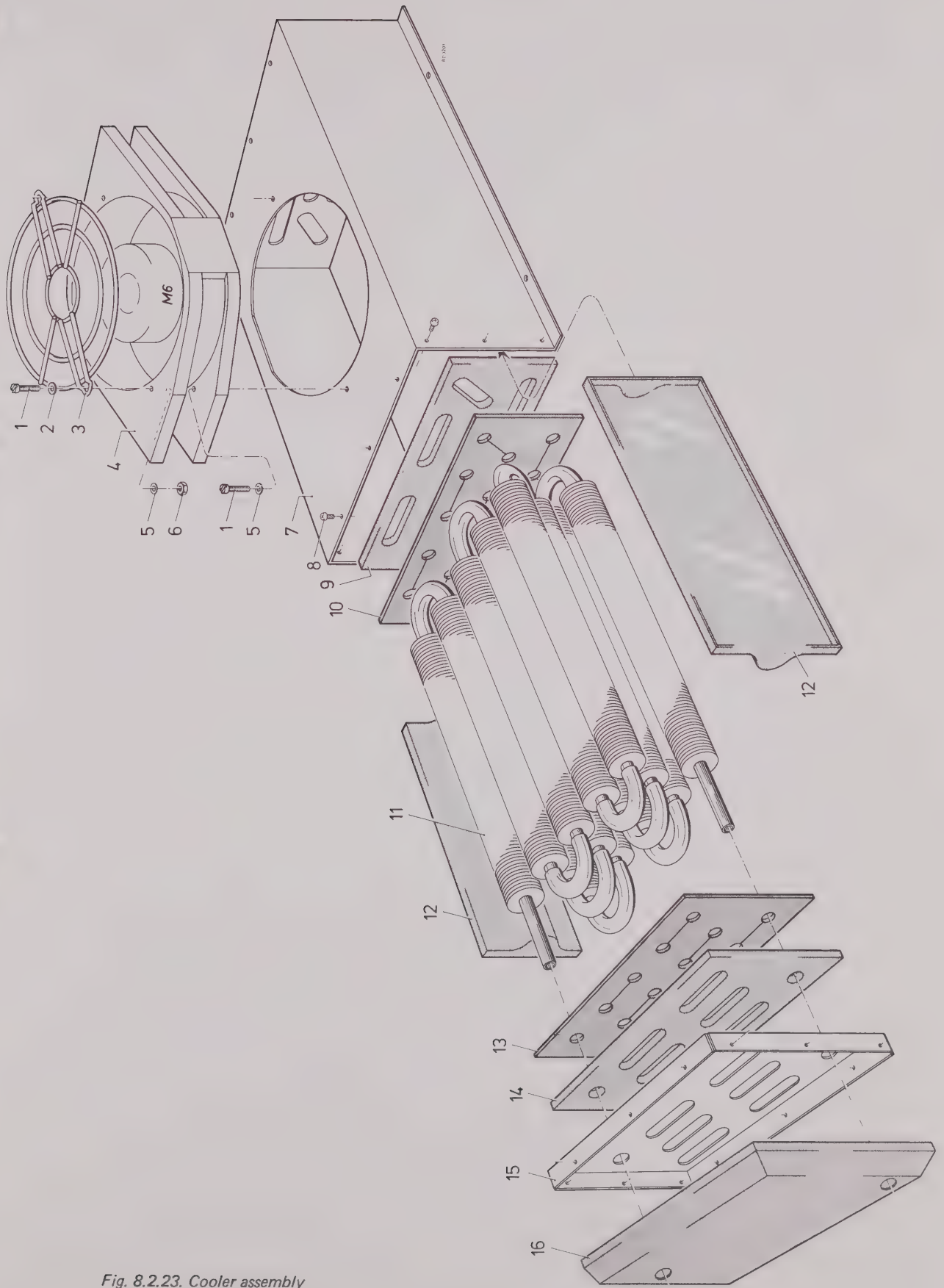


Fig. 8.2.23. Cooler assembly

8.2.24. Heater assembly

Item	*Description*	*Ordering code*
4	Heater element	5322 259 30103
25	Thermal cutout	5322 282 20065
30	Connector block 3-pole screw type	5322 290 64155
7	See Cooler assembly	

8.2.25. X-Ray on lamp unit

Item	*Description*	*Ordering code*
1	Cap	5322 447 94601
5	Lamp 6V 5W BAYONET FITTING 2 pase contacts	5322 134 44197
10	Tuchel connector 4-pole	5322 264 44007

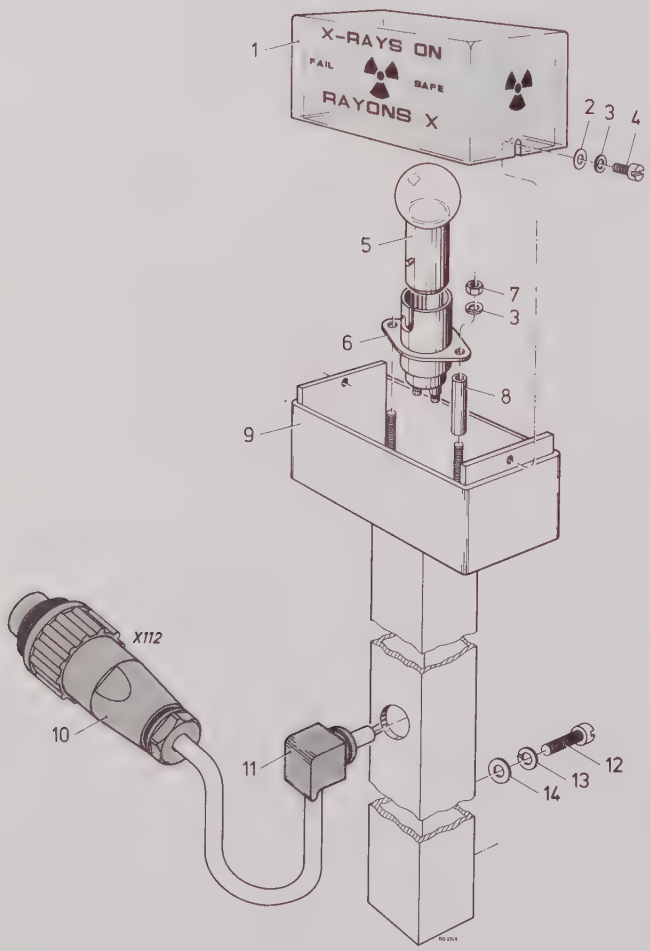


Fig. 8.2.25 X-Rays on lamp unit

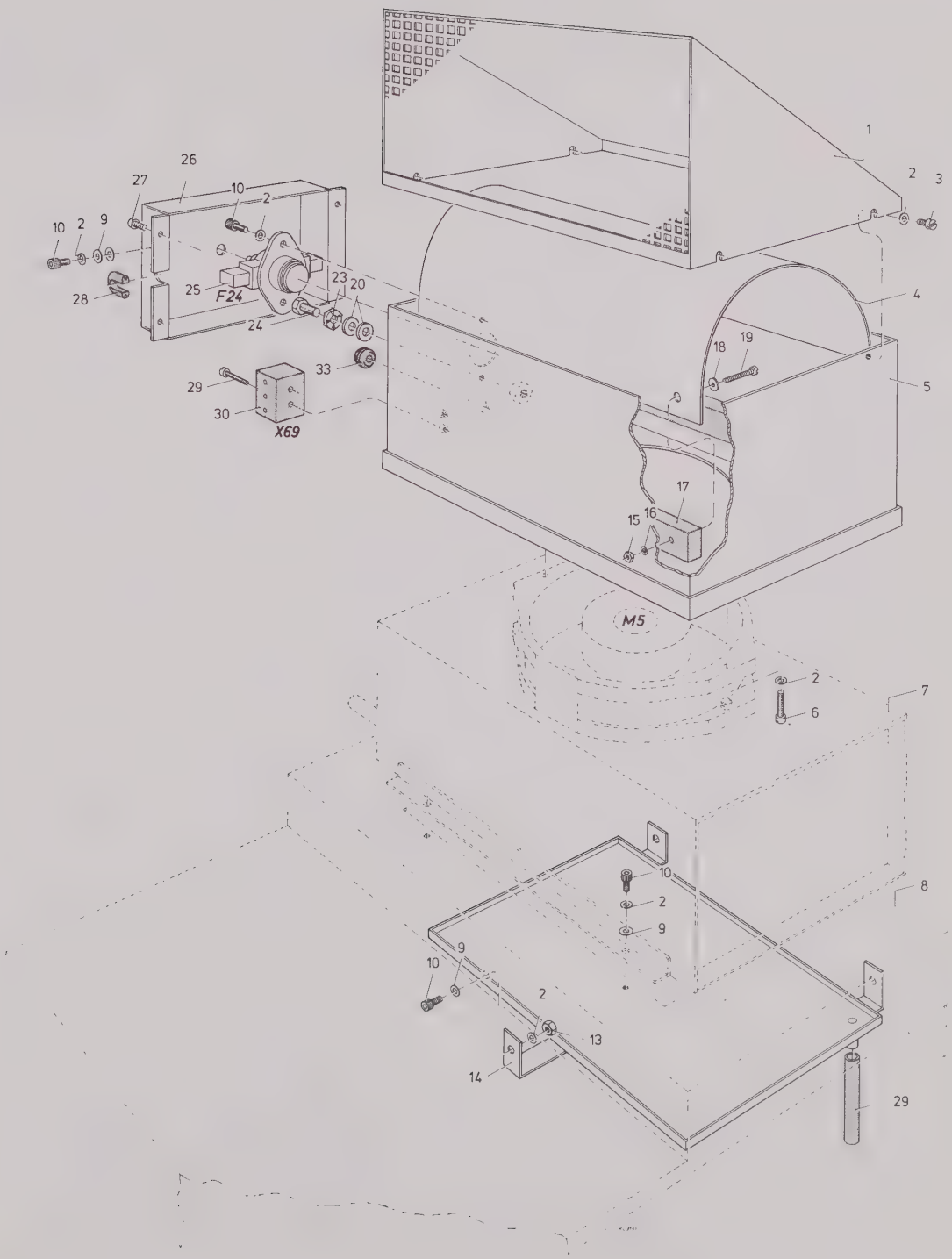


Fig. 8.2.24. Heater assembly

8.3. HELIUM SYSTEM PW 1464/50

Item	*Description*	*Ordering code*
1	Sealing washer	5322 532 54434
2	Reduction valve	5322 360 50271
3	Reduction valve	5322 360 50269
4	Hose connector	5322 526 44195
23	O-ring, Gaco R3275	5322 530 54335
24	Neoprene hose 11 x 5	5322 530 24052
28	Nipple 8 x 0,25 in	5322 526 44156
29	Sealing plug	5322 526 44046
34	O-ring, Gaco RMD265-30	5322 530 54574
35	Coupling piece	5322 526 44198
36	Vacuum valve	5322 360 54062
40	Hose coupling, 0,125 in	5322 526 44169
43	Adapter 0,25 x 0,375 in	5322 526 44194
45	Hose connector	5322 526 44045
49	PVC hose 10 x 7	5322 530 20236
50	Elbow union 8 x 0,25 in	5322 526 44193
53	Connecting block	5322 290 84046
56	Needle valve	5322 360 54063
57	Flowmeter for helium	5322 349 24011
63	Electromagnet coil 24 VDC	5322 281 64168
64	2/2 valve, Herion 92020-00-00000	5322 360 54004
65	T-piece	5322 526 44197
66	T-piece	5322 526 44196
75	3/2 valve, Herion 9340 7-21-0000	5322 281 24015

ADJUSTMENT UNIT

REGULATING VALVE

FLOWMETER

AIR INLET VALVE

MAIN VACUUM VALVE

VACUUM SWITCHTING VALVE

COMPRESSED AIR FROM PNEUMATIC UNIT

MANUAL AIR INLET VALVE

Y12 = AIRLOCK VACUUM VALVE
Y13 = AIRLOCK AIR INLET VALVE

DUST FILTER

REDUCTION VALVE

HELIUM

FORELINE TRAP

VALVE UNIT

HELIUM OUTLET VALVE

HELIUM INLET FLUSHING VALVE

HELIUM OUTLET FLUSHING VALVE

COMPRESSED AIR RETURN TO PNEUMATIC UNIT

HELIUM OUT

COMPRESSED AIR FROM PNEUMATIC UNIT

MAIN HELIUM VALVE

HELIUM INLET VALVE

VACUUM PUMP

O Ring

VACUUM OUTLET

Fig. 8.3.1. Helium system PW1464/50

8.4. CONTENTS OF SPARE PARTS KIT PW 1458/50

Item	*Qty.*	*Description*	*Factory code number*	*Service code number*
1	1	Magnetic valve 2/2 way	2922 031 90177	5322 360 54004
2	2	Magnetic valve 3/2 way	2922 031 90182	5322 281 24015
3	1	Magnetic valve 2/2 way	2922 031 90283	5322 360 54067
4	2	Hose connector, elbow	2922 006 24077	5322 526 44111
5	2	Hose connector, straight	2922 006 98087	5322 526 44045
6	2	Restriction 0.25mm	4022 332 14380	5322 532 24531
6	2	Restriction 0.4mm	4022 332 13870	5322 532 24529
7	1	Wire holder for flow detector	4022 189 53690	
7	1	Wire holder for flow detector	4022 189 99080	5322 694 14008
7	1	Insulating disc for flow detector	4022 189 99060	
7	1	Insulating disc for flow detector	4022 189 99080	
8	2	Contact spring for gas flow detector	4022 189 50210	5322 192 50801
9	1	Spinner shaft	4022 332 12910	5322 535 94881
10	1	Magnetic valve	2922 031 90287	5322 360 54064
11	1	Gear box (sample turret 25:1)	4022 332 13110	5322 522 14079
11	1	Gear box (spinner 50Hz 16,6:1)	4022 332 13120	5322 522 14081
11	1	Gear box (spinner 60Hz 20:1)	4022 332 13130	5322 522 14082
11	1	Gear box (crystal changer 60:1)	4022 332 14510	5322 522 14083
12	1	Stepping motor	4022 331 61590	5322 361 84207
13	1	Synchronous motor with pinion	4022 331 70230	5322 361 84208
14	1	Nylon hose 0.5m	4022 332 13860	5322 530 24095
15	1	Microswitch in holder screw connection	4022 331 66100	5322 271 34224
	2	Microswitch in holder faston connection (small roller)	4022 331 70890	5322 271 34226
	1	Microswitch in holder faston connection (large roller)	4022 331 66510	5322 271 34225
	2	Microswitch in holder (large roller)	4022 189 61910	5322 271 34064
	2	Microswitch in holder (small roller)	4022 188 23440	5322 271 34141
	2	Microswitch 2 pole 5A	2422 135 00141	5322 271 30003
	1	Microswitch 1 pole 10A	2422 120 00539	
18	1	Leaf spring with roller for microswitch	2422 135 00013	5322 402 50032
19	1	Leaf spring for microswitch	2422 135 00012	5322 492 60951
20	2	Insulating plate for microswitch	2422 135 00117	5322 466 94364
21	2	Electromagnet	2922 031 90201	5322 281 64156
22	2	Electromagnet	2922 031 90195	5322 281 64168
23	1	Solid state relay 240-D10	2422 132 05129	5322 280 74108
24	1	Scintillation detector	4022 331 52510	5322 214 74023
25	1	Null modem		
26	1	Serial interface PW1715/00	9430 017 15001	5322 694 14379
27	1	Preamplifier for scintillation detector	4022 322 82610	5322 694 14359
28	1	Preamplifier gas flow detector	4022 196 08890	5322 694 14393
	1	Amplifier-analyser pcb A1, A2	4022 331 70400	5322 694 14331
	1	Window control pcb A3	4022 331 70440	5322 694 14332
	1	Ratemeter pcb A4	4022 331 70410	5322 694 14333
	1	Counter-timer pcb A5	4022 331 70450	5322 694 14334
	1	Stepping motor control pcb A6	4022 331 70430	5322 694 14335
	1	Position control pcb A7	4022 331 70420	5322 694 14336
	1	Spectrometer control 1 pcb A8	4022 331 70460	5322 694 14337
	1	Spectrometer control 2 pcb A9	4022 331 70470	5322 694 14338

1	Spectrometer control 3 pcb	A10	4022 331 70480	5322 694 14339
1	Bus interface pcb	A15	4022 331 70390	5322 694 14341
1	Serial interface	A19, A20	9430 017 15001	5322 694 14379
1	Coil driver pcb	A31, 32	4022 331 70560	5322 694 14342
1	Power supply	A34	4022 331 70530	5322 694 14343
1	Motor drive pcb	A36	4022 331 70520	5322 694 14366
1	Stepping supply driver pcb	A37	4022 331 70500	5322 694 14365
1	Miscellaneous control pcb	A38	4022 331 70540	5322 694 14344
1	Generator safety control pcb	A39	4022 331 70550	5322 694 14345
1	High voltage suppl. pcb 1500V	A40	4022 331 70510	5322 694 14346
1	High voltage suppl. pcb 3000V	A41	4022 331 70490	5322 694 14347

● Recommended spares in addition to spare parts kit PW1458/50

1	CPU/ROM pcb	A16	4022 332 82290	9430 900 00391**
1	RAM pcb	A17	4022 332 82280	

** to be ordered via commercial channels.

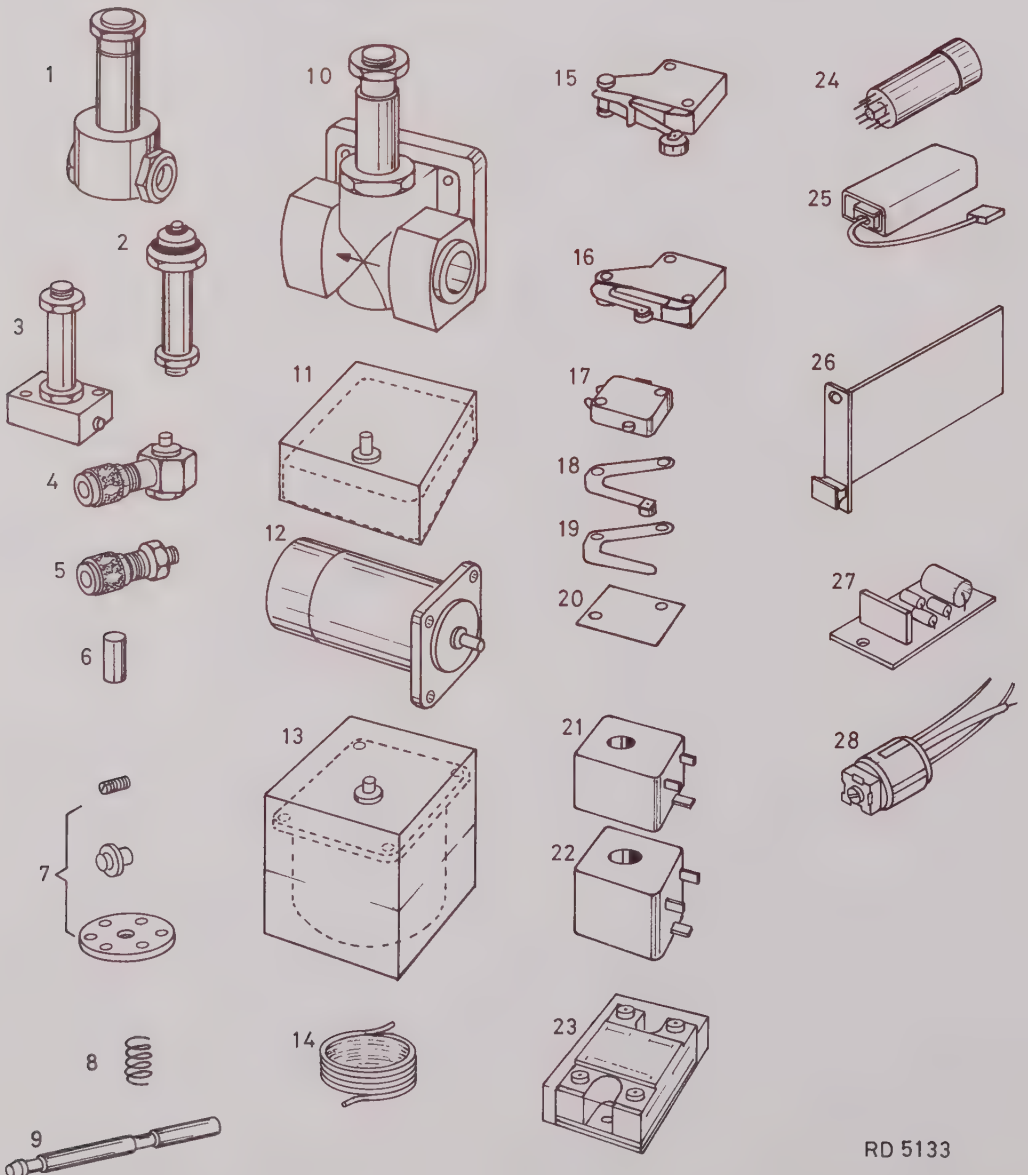


Fig. 8.4.1.

8.5. PW1500/0 . SAMPLE LOADER AND PW1500/1 . SAMPLE CHANGER

The lay-out of the printed circuit boards and the other electrical and electronic components is shown in fig. 8.5.

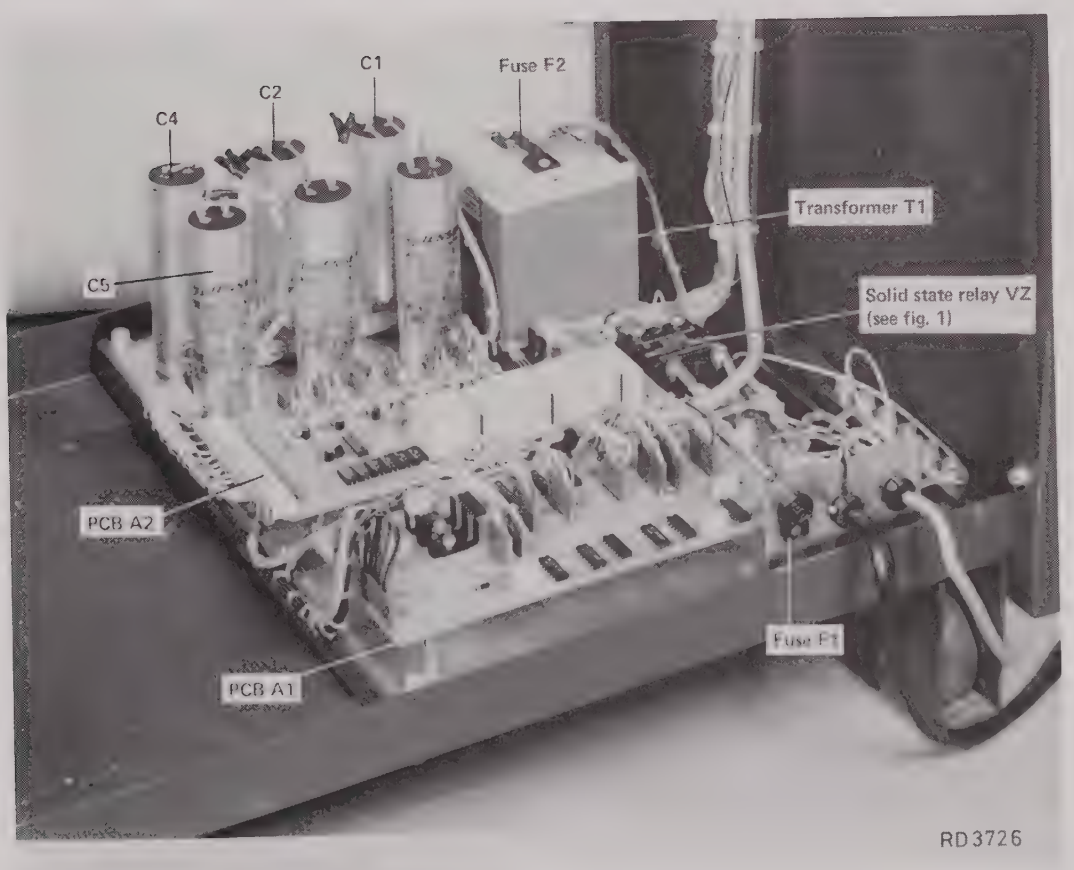


Fig. 8.5.1. Changer circuit panel lay-out.

8.5.1. Miscellaneous parts for PW1500/0. sample loader and PW1500/1. sample changer.

Item	Description	Ordering code
E1	Lamp 1287 5 12V 3W	5322 134 40146
Base V1	Transistor socket 4P	5322 255 40089
V1	Phototransistor	5322 130 44472
Both mounted	Light emitter	5322 130 34285
in spectrometer	Light receiver	5322 130 34286
Electronic rack assy		
For F1	Fuse holder 5 x 20	5322 256 34081
For F2	Spring fuse holder	5322 492 64336
Capacitors		
C1A, 2A, 4, 5	20 µF + 10 % – 10% 220V	5322 124 44011
C1B, 2B	25 µF + 10% – 10% 220 V	5322 124 44012
C3	4 µF Siemens 400 V	5322 121 14073
	50/60 Hz type B25833-A4405-K002	
F1	Cartridge fuse 1 AT	4822 253 30021
F2	Cartridge fuse 630 MA T 5 x 20	4822 253 30018
T1	Transformer TE 1650	5322 146 34091
	Solid state relay	
V2	Optrol 240-D10	5322 280 74108
Connectors		
	Wiring loom Y-motor 4022 332 64800	
X5C	Connector 4-pole Tuchel 3110-000	5322 265 34032
	Wiring loom arm mech 4022 332 64810	
X4A	Connector block RH	5322 265 54044
	25-pole pin Amp-205208-1	
	Contact pin Amp-66506-9	5322 268 14133
	Wiring loom optical reader 4022 332 64820	
X3	Contact block mod 4	5322 265 64028
	50-pole pin Amp 5-925369-0	
	Contact mod 4	5322 268 24108
	0,14 x 0,56 mm SO Amp 141603-3	

8.5.2. Sample changer control, pcb A11 (mounted in PW1400/00)

	Factory code	Ordering code
	4022 332 82780	5322 694 14378

Item	Description			Ordering code
Capacitors				
C1-3	100 NF	10%	100 V	5322 121 40323
C4, 5	33 μF	−10 +50 %	16 V	5322 124 24187
C6	4.7 NF	10%	100 V	4822 122 30128
Integrated circuits				
D1	HEF 4528 BP			5322 209 14191
D2, 5, 6, 13, 30, 42	HEF 4011 BP			5322 209 14046
D3, 4	HEF 4043 BP			5322 209 14244
D7, 8, 21	HEF 4009 BP			5322 209 14433
D9, 25, 27	HEF 4013 BP			5322 209 10002
D10, 33, 41	HEF 4023 BP			5322 209 14065
D11, 22, 28, 36	HEF 4001 BP			5322 209 14045
D12	HEF 4040 BP			5322 209 14269
D14-16	HEF 4556 BP			4822 209 10004
D17	HEF 4024 BP			5322 209 14103
D18	HEF 4085 BP			5322 209 14058
D20, 35	HEF 4012 BP			5322 209 14047
D23, 24, 19, 37	HEF 4071 BP			5322 209 14053
D26	HEF 4075 BP			5322 209 14067
D29	HEF 4078 BP			5322 209 14234
D31, 39	HEF 4044 BP			5322 209 14072
D32, 43	HEF 4081 BP			5322 209 14054
D34, 40	HEF 4069 UBP			5322 209 14128
D38	HEF 4072 BP			5322 209 14074
Diodes				
V1, 2, 3	BAW62			4822 130 30613
Resistors				
R1	1k21	1 %	MR25	5322 116 54557
R2, 3, 5	20k5	1 %	MR25	5322 116 54643
R4	10k	1 %	MR25	5322 116 54619
R6	40k2	1 %	MR25	5322 116 54665

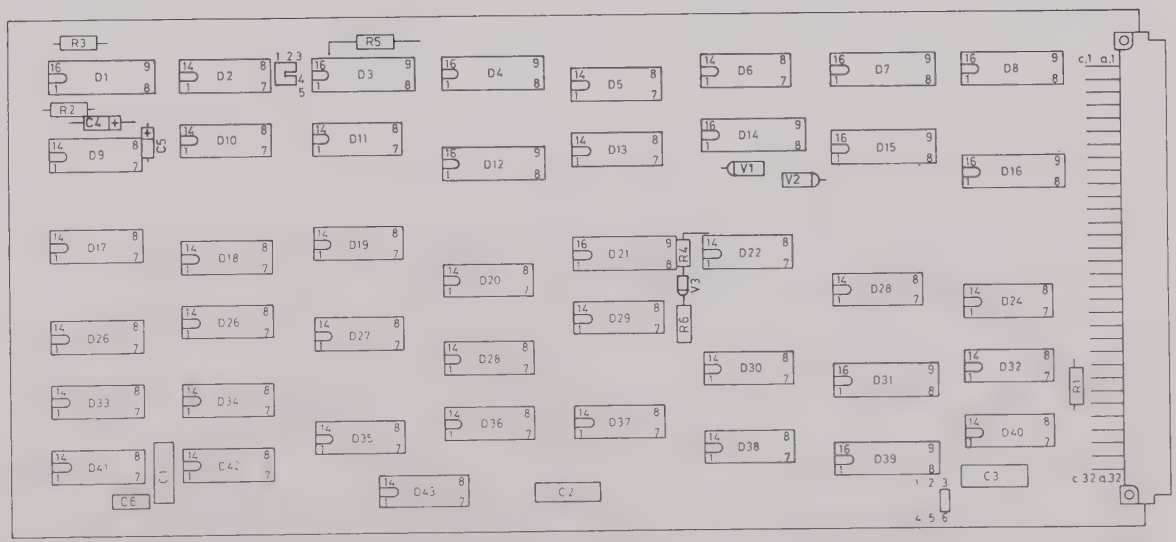


Figure 8.5.2. Sample Changer control pcb A11 – component lay out.

8.5.3. Microswitch buffer, pcb A1.

	Factory code	Ordering code
	4022 332 82790	5322 694 14377

Item	Description			Ordering code
Capacitors				
C1, 2, 18, 23, 7	100 NF	10%	100 V	5322 121 40323
C3-6, 8-17,19-22	10 NF	– 20 + 80%	40 V	4822 122 30043
C24	680 μ	– 10 + 50%	40V	4822 124 20534
Integrated circuits				
D1, 2, 7, 8	HEF 4044 BP			5322 209 14072
D3, 5, 6, 10, 11	HEF 4093 BP			5322 209 14186
D4, 9, 12	HEF 40098 BP			5322 209 14304
D13	7812 CU			5322 209 85603
Resistors				
R1-4, 9-16, 31, 32, 35-50	12 K	5%	CR 25	4822 110 63136
R5-8, 17-20	22 K	5%	CR 25	4822 110 63143
R22-30, 51-58	17K8	5%	CR 25	5322 116 54637
R59	1E82	5%	CR 37	5322 116 55503
R21	90K9	5%	CR 25	5322 116 54694
Diodes				
V11	BY 164			4822 130 30414
Transistors				
V6	BSS 51			5322 130 44451

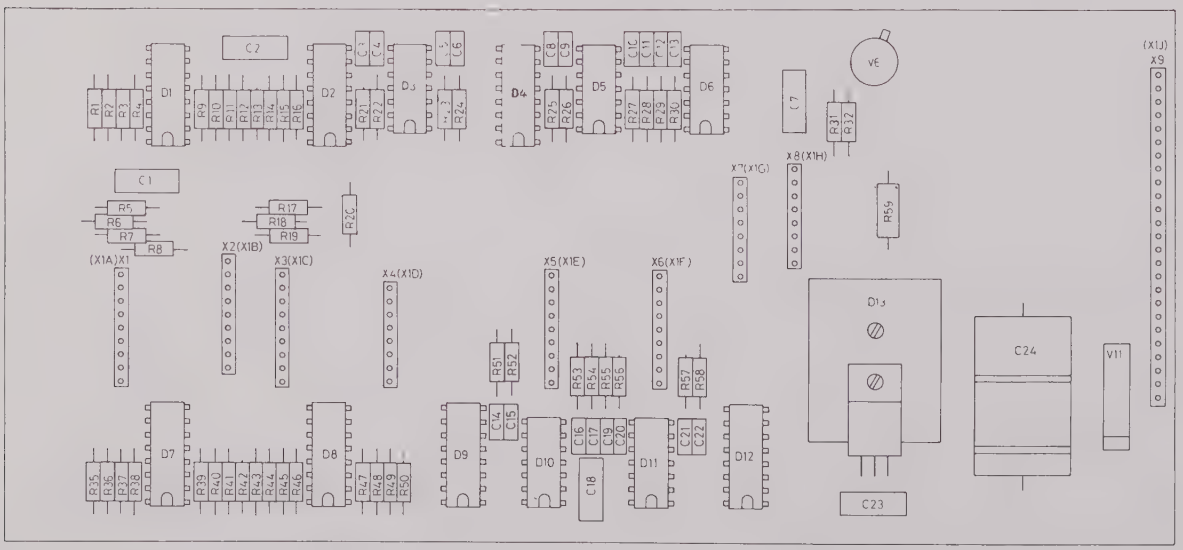


Fig. 8.5.3 Microswitch buffer pcb A1 — component layout.

8.5.4. Motor drive, pcb A2.

Factory code	Ordering code
4022 323 82550	5322 694 14366

Item	Description			Ordering code
Capacitors				
C1	680 µF	− 10 + 50 %	40 V	4822 124 20534
C2, 3, 5, 6, 8, 9	6,8 µF	10 %	100 V	4822 121 40252
C4, 7, 10	4,7 µF	10 %	100 V	5322 121 40224
C11	100 NF	10 %	100 V	5322 121 40323
Integrated circuits				
D1	HEF 4017 BP			5322 209 14444
D2-7	CNY 62			5322 209 86029
Fuses				
F1-6	1 A delayed 5 x 20			4822 253 30021
Resistors				
R1-6, 13-24, 27, 28	10 k	5 %	CR 25	4822 110 63134
R7-12	100 k	5 %	CR 25	4822 110 63161
R25	8E2	5 %	4,2 W	4822 112 21052
R26	620 E	5 %	CR 52	5322 116 55028
R29	1 k	5 %	CR 52	4822 110 43107
R30-32	15 E	5 %	7 W	4822 112 41058
R33-38	1 MA	5 %	56 V	4822 116 20101
R39-44	270 E	5 %	CR 37	4822 110 53092
R45	470 k	5 %	CR 25	4822 110 63178
Transistors				
V1-6	BC 547			4822 130 44257
V7-8	BC 557			4822 130 44256
V9	BD 138			4822 130 40665
Diodes				
V10	BY 206			4822 130 30839
V11	BZX 79-C12			4822 130 34197
V12, 13, 20	BAX 12A			5322 130 34605
V14-19	BT 139-600 triac			5322 130 24079

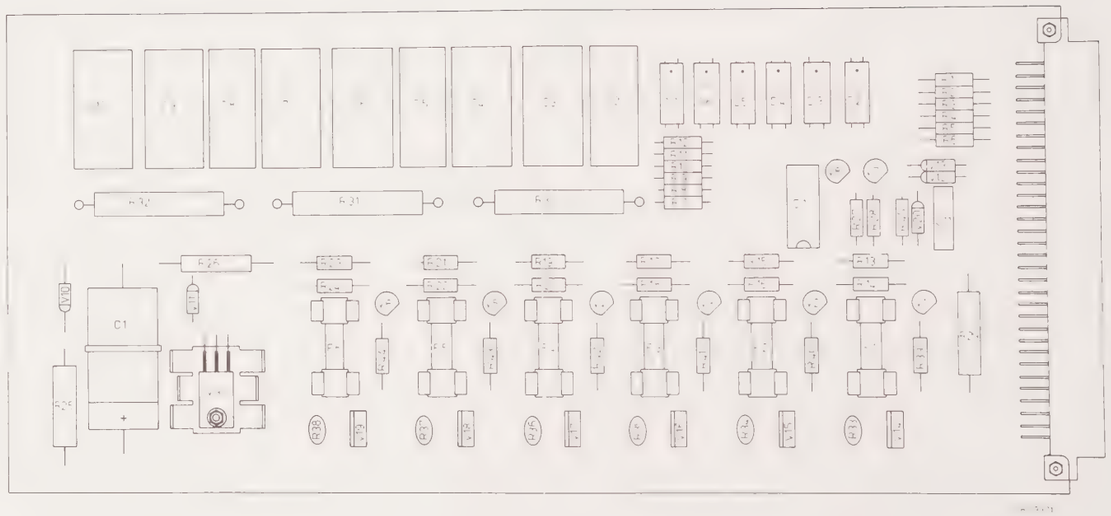
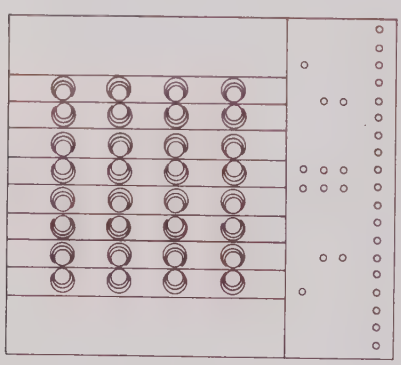
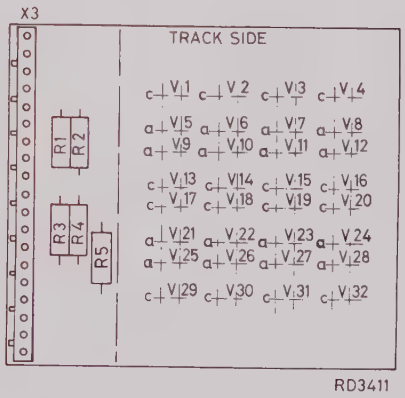


Fig. 8.5.4. Motor drive, pcb A2 – component layout.

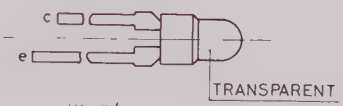
8.5.5. Optical reader, pcb A3

	Factory code			Ordering code
	4022 332 82930			5322 694 14388
Item	**Description**			**Ordering code**
Resistors				
R1-4	301 E	1 %	MR 25	5322 116 54508
R5	100 E	1 %	MR 25	5322 116 54469
Transistors				
V1-4, 13-21, 29-32	Phototransistor BPW 22			5322 130 44754
Diodes				
V5-12, 21-28	LED CQY 58 A/1			5322 130 34677
Connectors				
X3	Header strip 50-pole 180 deg Amp 5-825433-0			5322 265 64091





V5 T/M V12
V21 T/M V28



V1 T/M V4
V13 T/M V20
V29 T/M V32

Fig. 8.5.5. Optical reader pcb A3 – component layout.

8.5.6. Grab arm mechanism (common to both PW1500/00 and PW1500/10)

Item	Description	Ordering code
23-26	Grab arm slot pin (complete)	5322 535 74563
29	Sleeve bearing	5322 520 34173
24	Ball bearing single row sealed 5 x 16 x 5	5322 520 20122
26	Circlip 3.2 mm external	4822 530 70123
28	Ball bearing single row sealed 25 x 47 x 12	5322 520 24184
15	Slotted belville washer A8 SS 18	5322 530 84098
18	Cam	5322 466 85747
46	Self-aligning rod-end bearing M5	5322 520 14276
37	Clamp	5322 532 34112
43	Special bolt	5322 500 14246
67, 56 ... 60, 63	Grab assembly	5322 693 14011
80	Locking slide Cannon DB51221	5322 268 94008
M4, 5	Synchronous motor 24V 50 Hz	5322 361 84212
S1-6	Microswitch assembly	5322 271 34064
X4B	Connector block 6-p	5322 290 64152
X4A	Contact block 25-pole pin Amp 20S208-1	5322 265 54044
	Contact pin AMP 66509-9	5322 268 14133

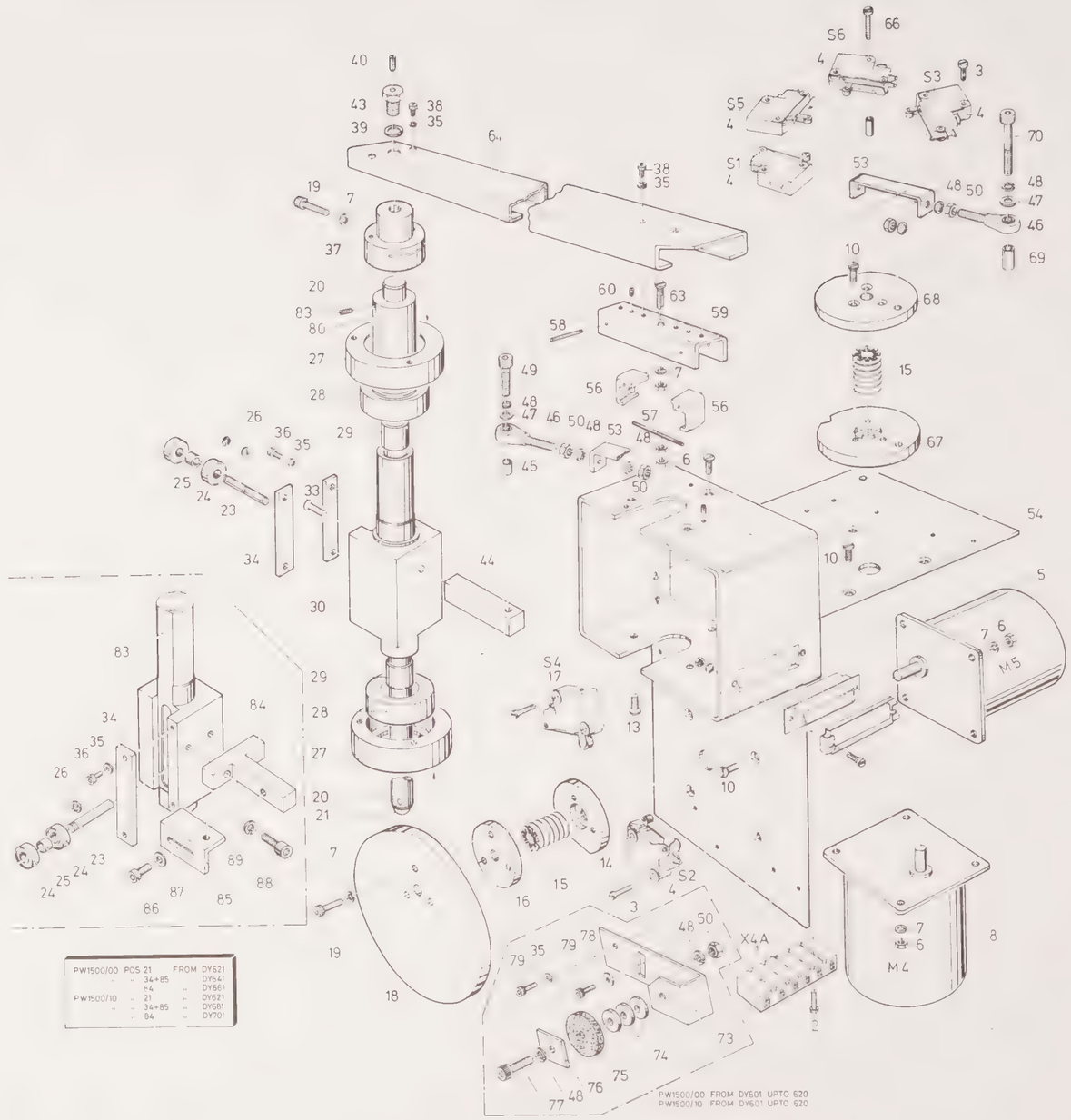
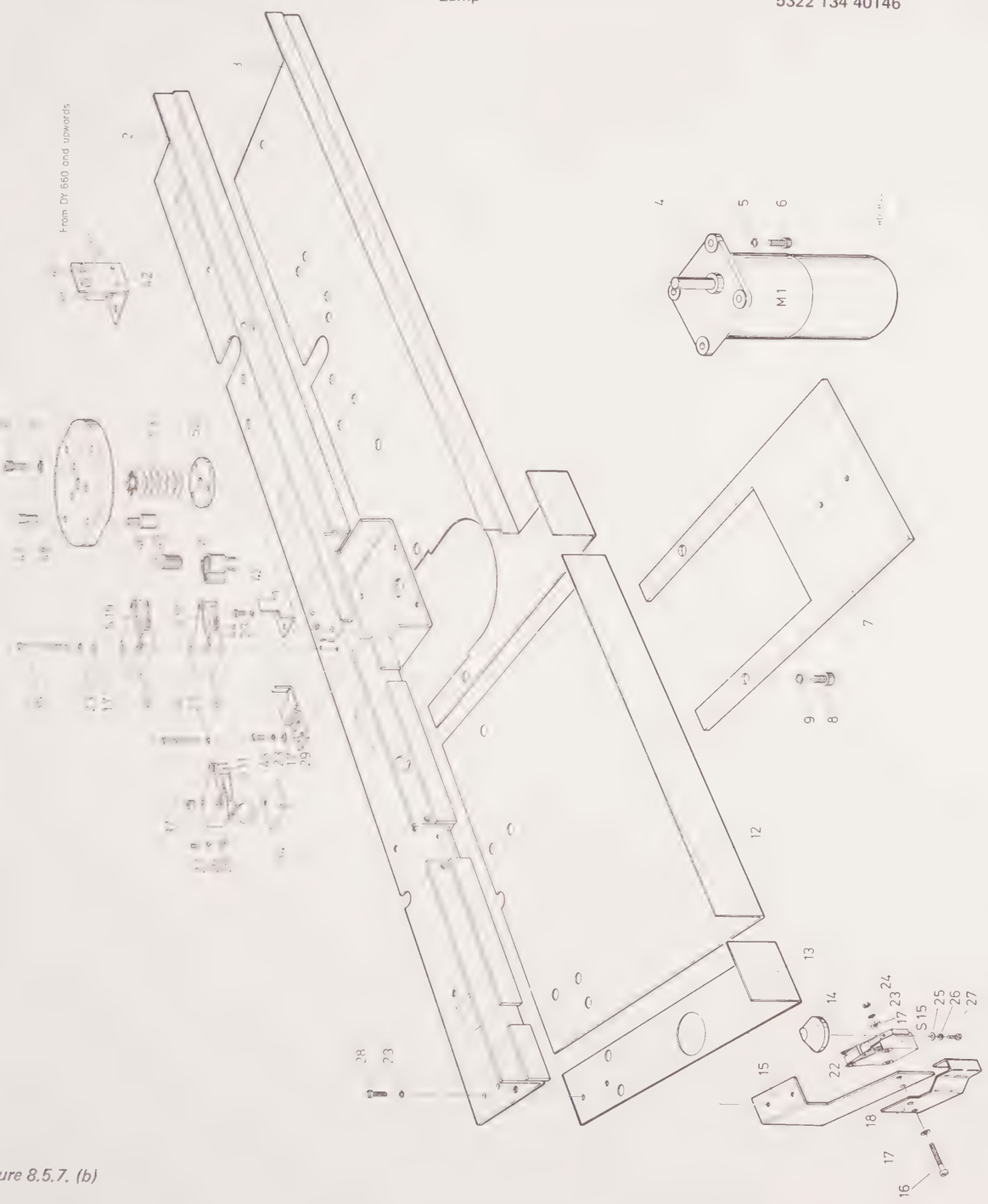


Figure 8.5.6. Grab arm mechanism

8.5.7. PW1500/00 sample loader mechanism

Item	Description	Ordering code
M1	Motor	5322 361 84211
S11, S15	Microswitch assembly 82790	5322 271 34194
S17, S19	Microswitch assembly	5322 271 34064
49	Lamp	5322 134 40146



ure 8.5.7. (b)

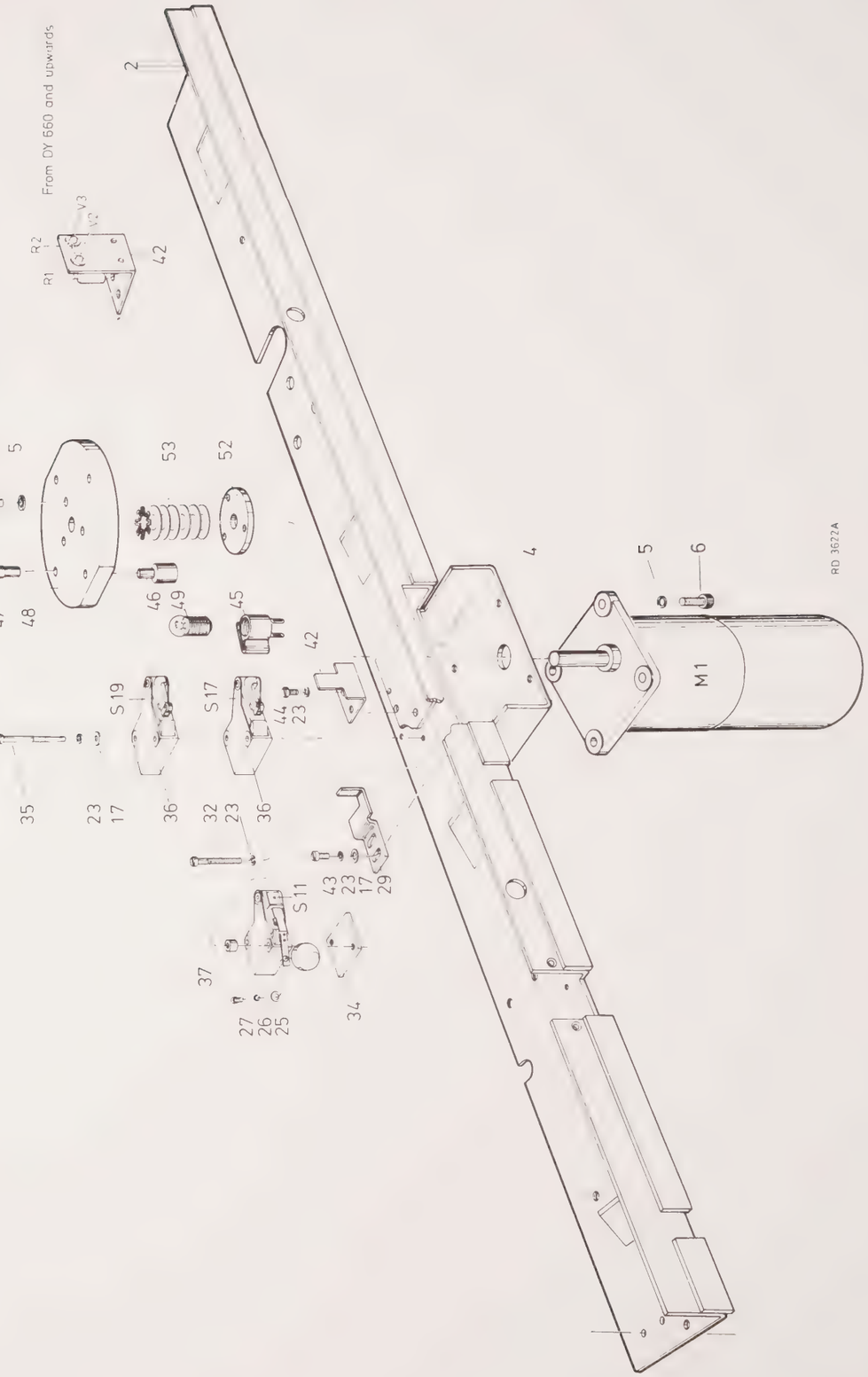


Figure 8.5.7. (c)

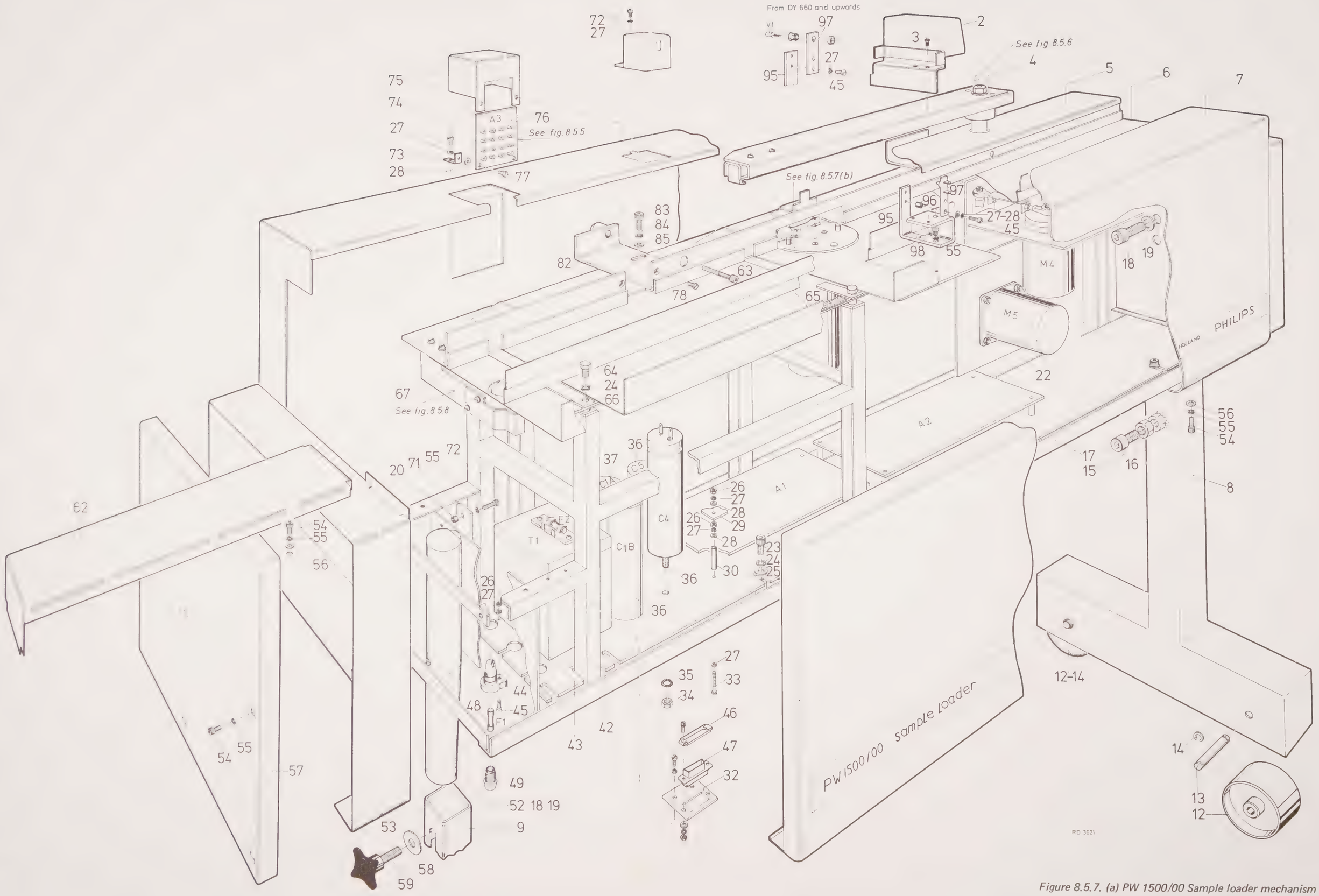


Figure 8.5.7. (a) PW 1500/00 Sample loader mechanism

8.5.8. PW1505/00 Reference tray option

8.5.8.1. Printed circuit board

Factory code	Ordering code
4022 332 83350	5322 694 14432

Item	Description			Ordering code
Capacitors				
C1	680 μF	−10+50%	40V	4822 124 20794
C2	100 nF	10%	100V	5322 121 40323
C3, 4	10 nF	−20+80%	40V	4822 122 30043
Integrated circuits				
D1	HEF 4049 BP			5322 209 14049
D2, 3	CNY 63 opto coupler			5322 130 94018
D4	78HV24CU volt. regulator			5322 209 86102
Resistors				
R1, 2	4 k 87	0.5%	MR 25	5322 116 55445
R3, 4	20 k 5	0.5%	MR 25	5322 116 55419
F1, 2	Fuse 500 MA delayed			4822 253 20014
Diodes				
V1	BY 164 diode			4822 130 30414
V2-4, 6	BAW 62 diode			4822 130 30613
V5, 7	BSS51 transistor			5322 130 44451

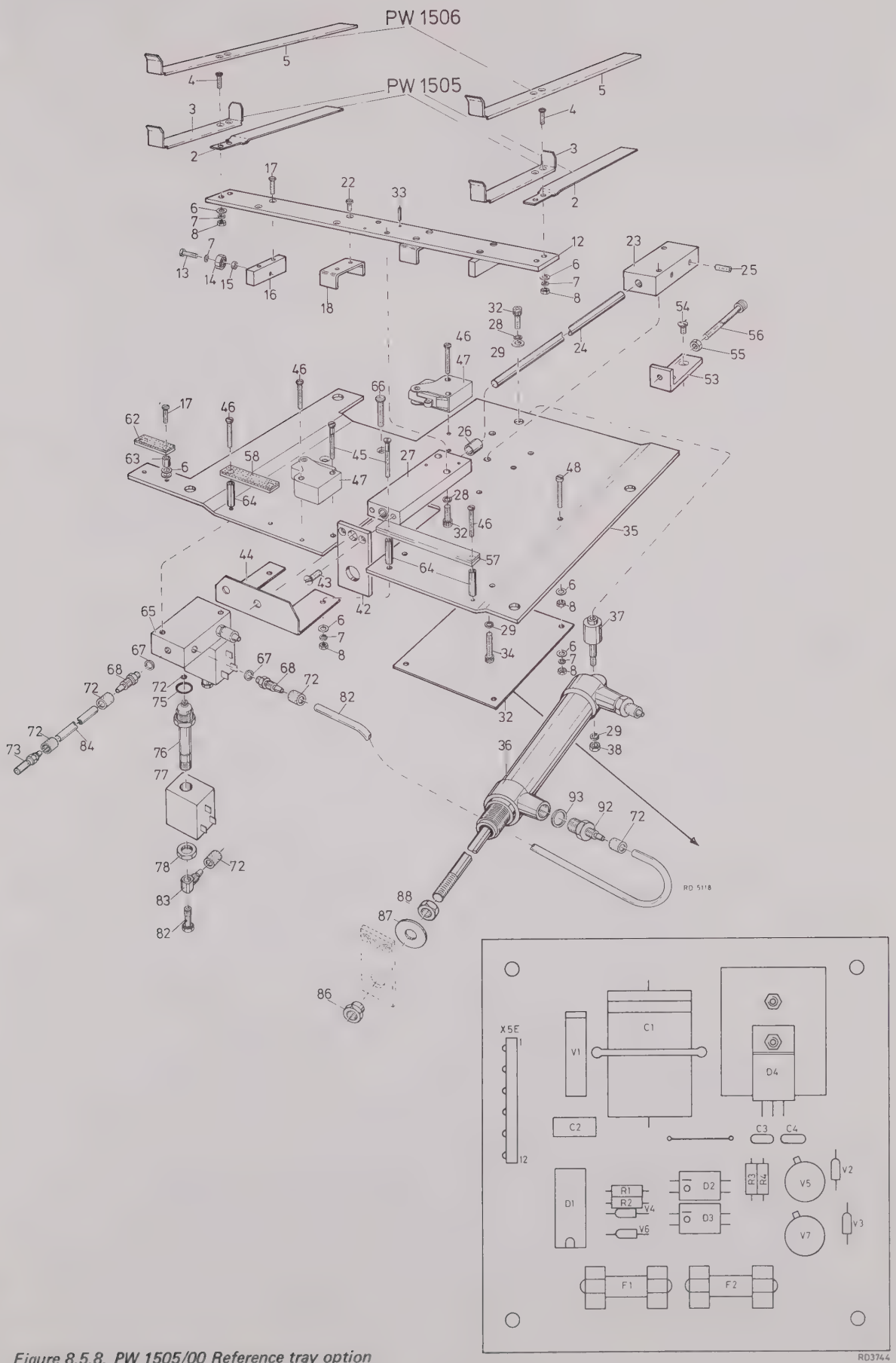


Figure 8.5.8. PW 1505/00 Reference tray option

8.5.9. PW1500/10 sample changer tray transport

Item	Description	Ordering code
	Locking slide 4022 331 63760	5322 268 44137
	Transport mechanism 4022 331 62230	
2	Spring dowel 3 x 24 mm	5322 529 50051
3	Transport wheel	5322 522 34775
4	Retaining ring	4822 530 70128
5	Ball bearing single row sealed 12 x 28 x 8	5322 520 20157
6	Drive belt	5322 535 94886
8	Spring dowel 3 x 20	5322 529 50049
9	Bevel gearwheel	5322 535 94877
26	Transport belt	5322 358 24108
37	Transport belt	5322 358 24109
38	Shaft	5322 535 94887
68	Pawl	5322 526 54248
69	Spring	5322 492 64669
79	Disc assembly	5322 466 85745
117	Ball bearing single row sealed 6 x 19 x 6	5322 520 20014
118	Transport wheel flat	5322 528 74213
C3	Capacitor 4 μ F 400 V	5322 121 14073
	Siemens 50/60 Hz type	
	B25833-A4405-K002	
M1,2	Motor	5322 361 84211
M3	Motor	5322 361 84209
S11, 12, 15, 16	Microswitch assembly	5322 271 34194
S13, 14	Microswitch assembly	5322 271 34195
S17, 18, 19	Microswitch assembly	5322 271 34064

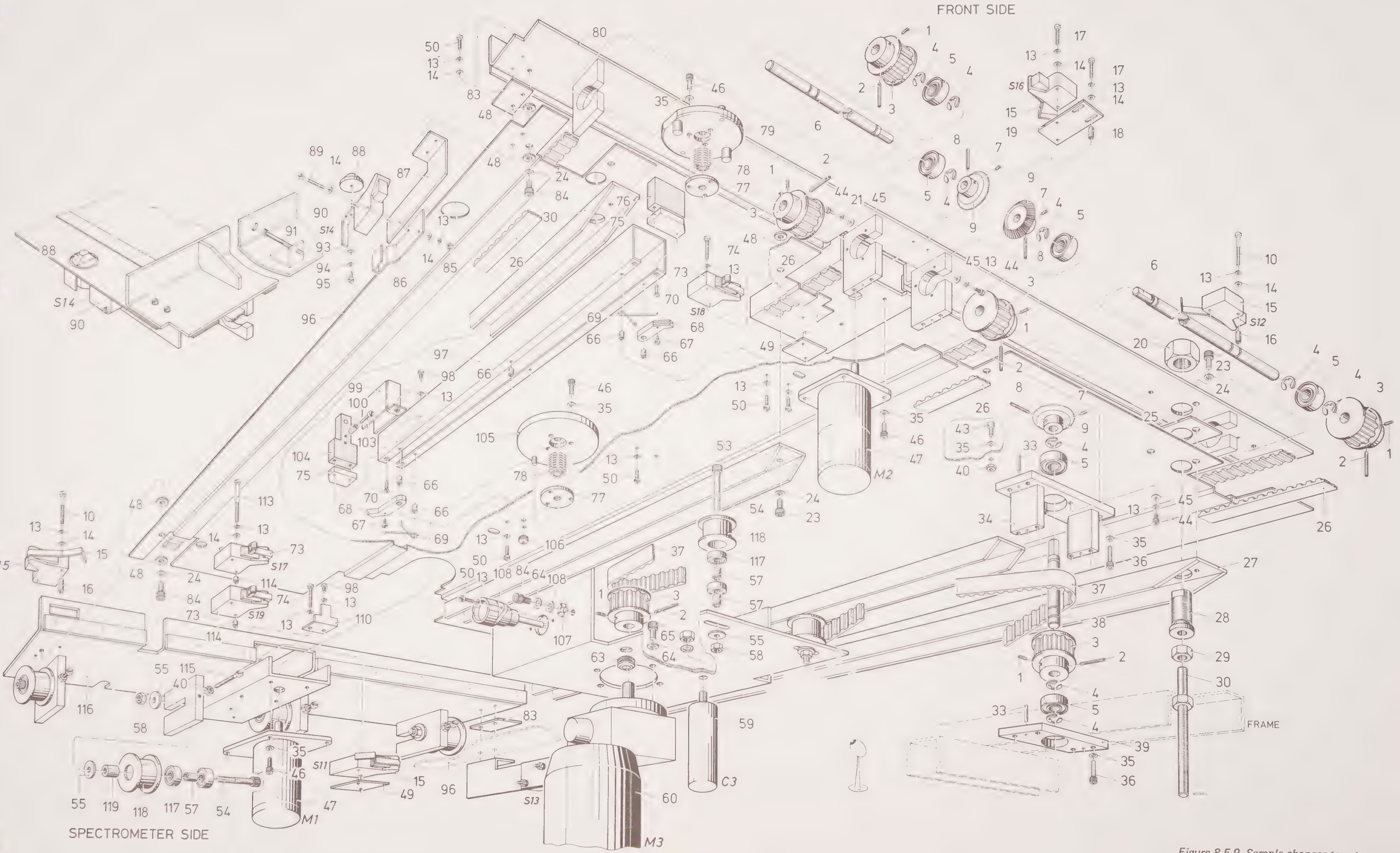


Figure 8.5.9. Sample changer tray transport

Parts delivered with PW1500/00/05/06 and PW1500/10/15/16.

Item	Qty.	Description	Factory code number	Service code number
	1	Sample changer control p.c.b.	4022 331 70650	5322 694 14378
	1	Light emitter	2711 032 01001	5322 130 34285
	1	Light receiver	2711 032 01011	5322 130 34286
	2	Coverplate	4022 332 18170	
	4	Screw/washer/spring washer		
	1	Allen key 8mm	2622 150 09022	4822 395 50092
	1	6mm	4022 331 70860	5322 395 54083
	10	Fuse 1A delayed	2422 086 00338	4822 253 30021
	10	Fuse 630mA delayed	2422 086 00336	4822 253 30018
	1	Lamp	4022 332 31430	5322 134 40146
		Screw driver	2622 150 11104	5322 395 50146

8.6. LIST OF CONSUMABLE MATERIALS

This section contains a list of materials for use during preventive and non-routine maintenance.

Description	*Factory code*	*Ordering code*
Shell Tellus 27 oil [50ml]	4822 720 70301	4822 390 10022
Shell Tellus 33 oil [150ml]	4022 189 45120	4822 390 10006
Edwards No. 16 Vacuum pump oil [5 litres]	1322 507 44302	5322 390 10044
Contact oil [4ml]	4022 320 04030	5322 390 14001
Dow Corning Molykote BR2 grease [30ml]	4822 720 70340	4822 390 20004
Dow Corning Molykote 44 grease [200g]	1322 510 22501	5322 390 24014
Wacker Silicone grease	1322 501 48202	5322 390 20011
Edwards Apiezon L [25g]	1322 504 76002	5322 390 20017
Dow Corning Molykote Mikrofine powder [35g]	1322 502 74102	5322 390 80125
Dow Corning Silastic 732 RTV Clear [56g]	1322 506 71901	4822 390 30029
CRC3-36 Anti-oxydent [2,5 litres]	1322 506 14206	5322 390 14005
Activated alumina, Edwards 09-H026-00-050 [11b]	4022 198 92260	5322 390 84003
Filter disc for gas system Millipore AAWG 02500	2822 060 20417	5322 480 40042
Filter element for airlock [3x]	4022 198 92290	5322 480 44007
Loctite 222 (for locking screws) [50ml]	1311 502 06002	
Loctite 242 (for locking nuts) [50ml]	1322 512 66702	
Loctite 542 (for water connections) [50ml]	1322 512 03102	
Loctite 601 (for fixing bearings etc.) [50ml]	1313 503 65602	
Loctite 496 (for rubber, metal etc.) [20ml]	1322 509 54203	

APPENDIX A

P817 SUPPLEMENT

Publication number 5122 991 28322

for

P800M OPERATOR'S GUIDE (5122 991 27442)

The P817 video display terminals are table top terminals, consisting of a display unit and a separate keyboard.

Two types are available: The P817-001, which is TTY compatible, operates in character mode, and has a 64 character set (96 character set on option), and the P817-002, which can operate in character or block mode, has a 96 character set, and offers extra features such as editing (insert/delete line or character), cursor sensing and addressing via the software, tabulation, and split screen operation. Both types have a 12 inch screen, providing 24 lines of 80 characters, a serial V24 interface, and self-contained power supply.
By means of hardware straps, the user can select several operational features: for both models the transmission rate (in the range 50 - 9600 bits/sec); odd, even or no parity; one or two stop bits, and the roll up function; for the P817-001 echoplex or direct operation, and for the P817-002 half/full duplex operation. Some strap-selectable functions can be changed from the keyboard in strap selection mode (P817-001 and P817-002), or via the software (P817-002 only).
Three keyboards are available: a TTY style keyboard (upper case only) for the standard P817-001, a typewriter style keyboard with upper and lower case characters and a numeric pad for the P817-001 with 96 character set, and an extended typewriter style keyboard with numeric pad and function keys for the P817-002.

The P817-001 can be extended with options to provide a 96 character set, blinking and underlining facility, and hard copy facility via an auxiliary device. For the P817-002 options are available for underlining, blinking and blanking, hard copy via an auxiliary device, and split screen operation. For both types, an optional plug-in current loop interface and an optional plug-in inplant modem is available, and both types can be equipped with an optional swivel stand for the display unit.

Figure 1 shows the P817-002 terminal, with swivel stand.

Fig. 1. P817-002

Operation

The P817 display terminals can operate ON LINE or OFF LINE. In OFF LINE mode, information entered on the keyboard is displayed on the screen, but not sent to the system; in ON LINE mode information entered from the keyboard is displayed on the screen and sent to the system, either character by character (P817-001 and P817-002), or as blocks consisting of one or more lines (P918-002 only).

Strap Selectable Functions

Several application-dependent operational features of the P817 display terminals can be selected by hardware straps on the logic board inside the display unit. These features include:

- for P817-001/002: transmission rate
  odd, even or no parity
  roll up function
  number of stop bits
  echoplex/direct operation
- for P817-002: half/full duplex operation
  split screen size
  roll up function for split screen (parts)
  character/block mode

The strap selectable functions can be changed from the keyboard in "strap selection mode". In P817-002 terminals, the straps set for character or block mode, for screen part size and for the roll up functions for the two screen parts can be changed via the software (see section "Software Commands").

The strap selection mode is entered by pressing the Cursor Left key together with the CNTL key. The screen will be cleared, and "XXXSSSXXX" is displayed on the top line of the screen to indicate that the terminal is in strap selection mode, and the cursor is placed in the first character position on the second line. The functions selected by straps are changed by typing in commands, each starting at the first character position of a new line. If two different commands are entered for the same function, only the last command is effective. The strap selection mode is left by typing in a period (.) on a new line. If all commmands were correct, the screen is cleared to indicate that the commands have been executed, and the normal operational mode is entered, In case of errors, the screen is not cleared, the erroneous lines are marked with "XXX" after the last character in the line, and the period is removed to indicate that the terminal is still in the strap selection mode. The operator can enter the correct commands, and leave the strap selection mode as described above.

The keyboard commands to change the strap-selected functions are:

TR x	transmission rate "x" bits/sec, "x" must be one of the values 50, 75, 110, 134,5, 150, 200, 300, 600, 1200, 1800 2400, 4800 or 9600.	
PO	odd parity	
PE	even parity	
PN	no parity	
RU	roll up function available	
RN	roll up function not available	
SB 1	1 stop bit	
SB 2	2 stop bits	
EP	echoplex operation	(all characters entered from the keyboard are sent to the CPU first, and then echoed back to the screen)
EN	direct operation	(all characters entered from the keyboard are sent to the CPU and the screen directly)
DH	half duplex	(P817-002 only)
DF	full duplex	(P817-002 only)
MC	character mode	(P817-002 only)
MB	block mode	(P817-002 only)

The commands EP/EN cannot be used for P817-002 terminals operating in block mode.

> **NOTE**
>
> When the terminal is switched off and switched on again, the functions selected from the keyboard are discarded, and the function selection by hardware straps is valid again.

Split Screen

In P817-002 terminals with the split screen option, the screen area can be divided into two independent parts. The number of lines for the upper screen part can be selected by hardware straps in the range 0 (no split screen) to 23 lines. All keyboard functions apply only to the screen part in which the cursor is present, or to the whole screen if the option is not present or the split screen feature has not been selected. All software commands defined for a complete screen apply to a screen part if split screen has been selected. Software commands not specifying an explicit line number apply to the screen part in which the cursor is present; software commands specifying an explicit line number apply to that line, independent of the split screen.
The following commands can be used in "strap selection mode" to change the split screen functions:

SS x	x lines in upper screen part ($0 \leqslant x \leqslant 23$)
RUY	roll up function available for upper screen part
RUN	roll up function not available for upper screen part
RLY	roll up function available for lower screen part
RLN	roll up function not available for lower screen part

Protected fields

In P817-002 terminals any number of characters on the screen can be specified via the software as "protected fields". These characters, which are displayed at about 2/3 of normal intensity, are protected against over-writing from the keyboard, and are not transmitted after a transmit command. Cursor control keys can bring the cursor into protected fields, but even then it is not possible to change the contents of those fields.

Controls and Indicators

The P817-001 and P817-002 have the following common controls:

Power on/off	a combined push button and indicator light in the lower right hand corner on the front side of the display unit. When power has been switched on, the indicator (white) is lit.
ON LINE/OFF LINE	a switch at the back of the display unit. When switched to "OFF LINE", only the characters entered from the keyboard are displayed on the screen.
Brightness control	a thumbwheel on the lower front side of the display unit, used to vary the brightness of the screen image.
Cursor	a white square, displayed on the screen to indicate the current character position.

Keyboards

The three types of keyboard available for the P817 terminal are:

- keyboard P817-051: a 64 character TTY style keyboard, with an alphanumeric part (upper case characters only), 4 function keys, and 2 indicators
- key board P817-052: a 96 character typewriter style keyboard, with an alphanumeric part (upper and lower case), a CAPS LOCK key (with indicator) which converts the keyboard to a TTY style keyboard, a numeric pad, 4 function keys and 2 indicators
- keyboard P817-053: a 96 character typewriter style keyboard, with an alphanumeric part (upper and lower case) which can be converted to a TTY style keyboard by means of a CAPS LOCK key (with indicator) a numeric pad, 20 fucntion keys and 8 indicators.

All three keyboards have n-key roll over function (i.e. all keys pressed at the same time are scanned and actioned sequentially), and all keys have "type-a-matic" function: the function of any key pressed for more than one second is repeated at a rate of ca. 12 times a second.
All three keyboards have a SHIFT key, which gives most alphanumeric keys a double function, and a CNTL key, which gives a second or third function to certain function keys.

> **NOTE**
>
> The location of some alphanumeric keys is different for national versions of the keyboards; in the illustrations the letter inscriptions on the keys are shown as in the English version, the symbol key inscriptions (which differ for all national versions) are not shown.

Keyboard P817-051

Keyboard model 001 is shown in fig. 2. Apart from the alphanumeric part, which is identical to a normal typewriter, the keyboard contains the keys and indicators listed below.

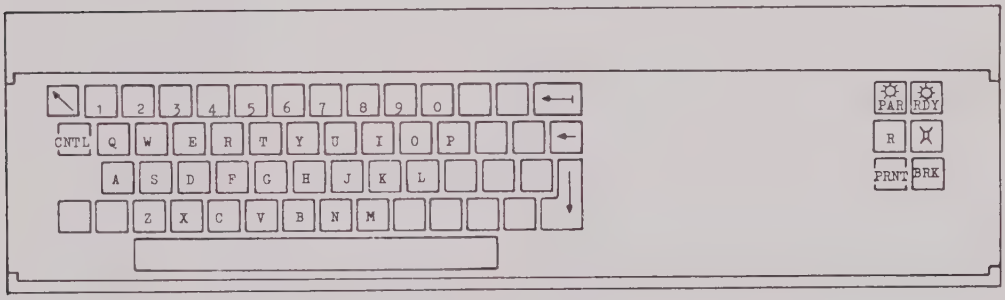


Fig. 2. Keyboard P817-051

CURSOR HOME

Moves the cursor to the first character position on the top line of the screen.

CURSOR LEFT

Moves the cursor one character position to the left.
If the cursor already was at the first position of the first line, nothing happens: if the cursor was at the first position of any other line, it is moved to the last position on the previous line.

CURSOR RETURN

Moves the cursor to the first character position of the current line.

CURSOR DOWN

Moves the cursor to the same character position on the next line. If the cursor already is on the bottom line, and the roll up function is not wired, the cursor remains in position. If the roll up function is wired, all characters on the screen move one line up, and the top line is lost.

BREAK

Sends "break" condition to the CPU.

CLEAR SCREEN

Clears the display screen, and puts the cursor in the home position.

PRINT LINE/PRINT PAGE

Copies the contents of the line in which the cursor is present, on the auxiliary device. The line is copied from the first character position up to and including the current cursor position. When the line has been copied completely, a "Carriage Return/ Line Feed" is generated for the auxiliary device.
If the PRNT key is pressed together with the CNTL key, the contents of the screen, from the first character position on the first line up to and including the current cursor position, are copied on the auxiliary device. At the end of each line "Carriage Return/Line Feed" is generated for the auxiliary device.

PARITY ERROR INDICATOR

The Parity Error Indicator lights when a character is received with incorrect parity, and remains lit until the parity reset (R) key is pressed.

PARITY RESET

Clears the parity error condition.

DATA SET READY INDICATOR

The data set ready indicator lights when the terminal is ready for operation.

Keyboard P817-052

Keyboard P817-052 is shown in fig. 3. It is a keyboard P817-051, extended with a CAPS LOCK key and indicator, and a numeric pad.
The alphanumeric part operates in the same way as a normal typewriter keyboard: upper case characters are generated by pressing the SHIFT key together with the required character key.
The CAPS LOCK key converts the keyboard to a keyboard model 001 (64 characters, upper case only), which is indicated by the CAPS indicator.
The numeric pad is used to enter the numeric values indicated on the keys. The key marked 00 generates two zeroes, the key marked 000 three zeroes, the key marked . a decimal point, and the key marked — a minus

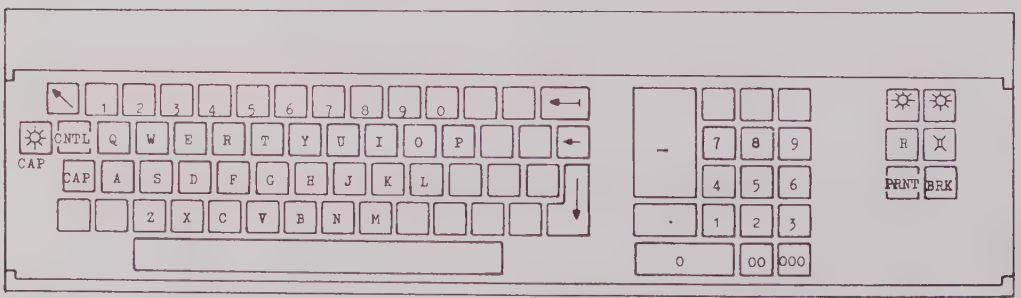


Fig. 3. Keyboard P817-052

Keyboard P817-053

The keyboard P817-053 contains an alphanumeric part and numeric pad identical to the keyboard P817-052 (except for the Cursor Down key, see below), and additional function keys and indicators. The keyboard P817-053 is shown in fig. 4.

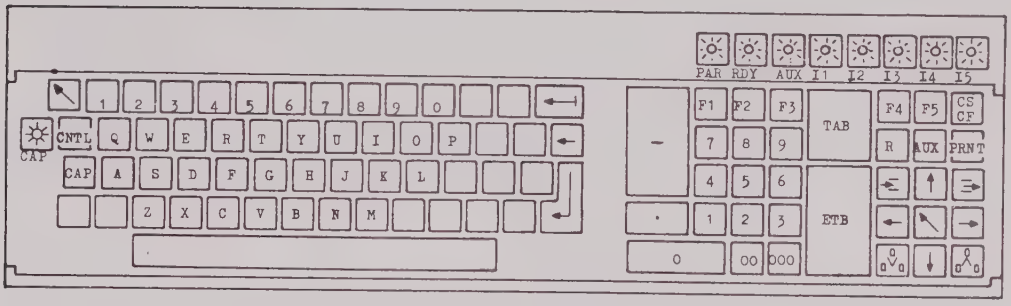


Fig. 4. Keyboard P817-053

The keys and indicators on keyboard P817-053 different from the ones on keyboard P817-051 and/or P817-053 are:

CURSOR RETURN NEXT LINE

Moves the cursor to the first character position on the next line. If the cursor was on the bottom line, nothing happens if the roll up function is not wired; all lines move up on position if the roll up function is wired.

TRANSMIT LINE (without CNTL)
TRANSMIT PAGE (with CNTL)

If pressed without the CNTL key, all characters from all unprotected fields in the line where the cursor is present are transmitted, up to the current cursor position. The last character of each unprotected field is followed by the code for HT (/09), the complete line is followed by the code EM (/19).

If the ETB key is pressed together with the CNTL key, all characters from all unprotected fields, from the first character position on the first line, up to and including the current cursor position, are transmitted. The last character of each unprotected field is followed by the HT (/09) code, each line is followed by the codes for Cursor Return (/0D) and Line Feed (/0A), and the completely transmitted page is followed by the code EM (/19).

CURSOR HORIZONTAL TABULATION (without CNTL)
CURSOR HORIZONTAL BACK TABULATION (with CNTL)

Pressed without the CNTL key, the TAB key moves the cursor to the first character position in the next unprotected field.
Pressed together with the CNTL key, the TAB key moves the cursor to the first character position in the current (unprotected) field. If the cursor already is in the first position of an unprotected, the cursor is moved to the first position of the previous unprotected field.

CURSOR UP

Moves the cursor to the same character position on the preceding line.

CURSOR DOWN

Moves the cursor to the same character position on the next line.

CURSOR HOME

Moves the cursor to the first character position on the first line.

CURSOR BACK

Moves the cursor one character position back on the same line, or to the last character position on the previous line if the cursor already was in the first position of a line.

CURSOR FORWARD

Moves the cursor one position forward on the same line, or to the first position on the next line, or to the first position on the next line if the cursor already was in the last position of a line. If the cursor was in the last position of the bottom line and the roll up function is wired, a roll up occurs.

INSERT LINE

Inserts a blank line at the current cursor position.
The current line and all following lines move one line down, and the last line is lost.
If the roll up function is not wired, the Insert Line function can be inhibited by means of a strap.

DELETE LINE

Deletes the current line. All following lines move one line up. If the roll up function is not wired, the Delete Line function can be inhibited by means of a strap.

INSERT CHARACTER

Inserts a space-character at the current cursor position. All characters to the right of the cursor move one position to the right. Characters shifted over the end of the line or into protected fields are lost.

DELETE CHARACTER

Deletes the character at the current cursor position. All characters to the right of the cursor up to the end of the line or the end of the unprotected field are shifted one position to the left, and a null-character is added in the vacated character position.

CLEAR FOREGROUND (without CNTL)
CLEAR SCREEN (With CNTL)
CLEAR FOREGROUND clears all unprotected fields on the screen, from the current cursor position to the end of the screen. CLEAR SCREEN clears the complete screen image, independent from the split screen function. All attributes are set to the initial state.

PROGRAM CONTROL KEYS

Each key Fx (1 x 5) transmits a Program Control Key Report to the CPU. The Program Control Key Report has the format CSI-p/73-EM, in which CSI is the Control Sequence Introducer consisting of the characters /1B and /5B, p is a two-character key code (/30 /3x if key Fx is pressed without the CNTL key, /31 /3x if key Fx is pressed with the CNTL key, and EM (/19) is the code indicating the end of the message.

FUNCTION indicators I1-I5

The function indicators I1-I5 can be lit by software commands from the CPU, see section "Software Commands".

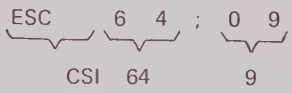
Software Commands

Software commands are sent from the CPU to the terminal, to control the operation of the terminal or to display data on the screen, or from the terminal to the CPU to report the device status.
Software commands may consist of a single code (e.g. for alphanumeric characters to be displayed on the screen, or /0B for Cursor Home), a single code preceded by the ESC (/1B) code (e.g. /1B /62, for Enable Manual Input), a control sequence consisting of a Control Sequence Introducer (CSI) code (ESC-/5B), parameters, and a final code (e.g. CSI-p-/43, for Cursor Forward p Positions), or a Device Control String, which consists of a Device Control String Sequence Introducer (DSC, code ESC-/50), parameters, and a Sequence Terminator (ST, code ESC-/5C).
Each parameter in a control sequence or a device control string sequence consists of at most two decimal digits, represented by their hexadecimal value in ASCII-code. For example, a parameter with value 9 will be coded as /30-/39, a parameter with value 64 as /36-/34. If a command contains more than one parameter, the parameters are separated by; (code /3B).

EXAMPLE

The command Cursor Position, CSI-n-p/48, which positions the cursor at the n-th position of the p-th line, with parameter values n = 64 and p = 9 is coded as

/1B-/5B-/36-/34-/3B/30-/39-/48



Common Software Commands

The software commands described below are common for the terminals P817-001 and P817-002.

mnemonic	function, code and meaning
BELL	BELL — code /07 The horn in the display unit sounds for 0.3 seconds
BS	CURSOR LEFT — code /08 The cursor is moved one position to the left. If the cursor already is on the first character position of the first line, nothing happens; if the cursor was at the first position of any other line, it is moved to last position on the previous line.
LF	LINE FEED — code /0A The cursor is moved to the same character position on the next line. If the cursor already is on the bottom line and the roll up function is not wired, nothing happens. If the roll up function is available, all lines move one position up, and the bottom line is filled with null-characters.
VT	CURSOR HOME — code /0B The cursor is moved to the first character position on the top line.
FF	CLEAR SCREEN — code /0C The screen image is cleared, and the cursor is moved to the cursor home position. The keyboard becomes unlocked (see command ENI below). If CLEAR SCREEN is given in the strap selection mode, the indication xxxSSSxxx will stay on the first line, and the cursor will be placed in the first character position on the second line.
CR	CURSOR RETURN — code /0D The cursor is moved to the first character position of the current line.
DMI	INHIBIT MANUAL INPUT — code ESC-/60 The keyboard is locked, and all keyboard input is ignored (except for the Clear Screen Key). If a key is pressed, the horn sounds for 0.1 second.
ENI	ENABLE MANUAL INPUT — code ESC-/62 The keyboard is unlocked, and the Inhibit Manual Input state is reset.

MC (0) MEDIA COPY (PAGE) code CSI-/30-/69

The contents of the screen, from the first character on the top line up to and including the current cursor postion, are copied on the auxiliary device. At the end of each line "Carriage Return/Line Feed" is generated for the auxiliary device.

MC(6) MEDIA COPY (LINE) code SCI-/36-/69

The line on which the cursor is present is copied on the auxiliary device, from the first character position of the line up to and including the current cursor possition. At the end of the line "Carriage Return/line Feed" is generated for the auxiliary device.

DSR(0) DEVICE STATUS REPORT (0) code CSI-/30-/6E

The Device Status Report with parameter value 0 is sent from the terminal to the CPU, to indicate that the copy requested by a Media Copy command is ready.

DSR(6) DEVICE STATUS REPORT (6) code CSI-/36-/6E

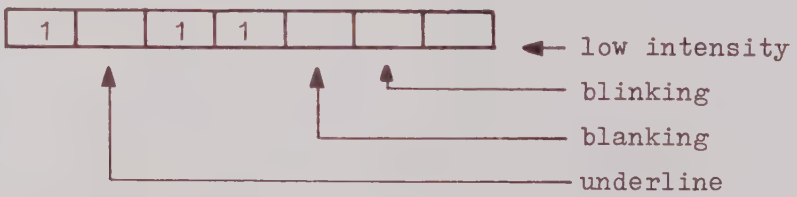
The Device Status Report with parameter value 6 is sent from the terminal to the CPU, to indicate that the copying operation requested by a Media Copy command has not been executed properly (e.g. because device was not operable). To retry, a new Media Copy command must be issued.

SAT SET ATTRIBUTES code DCS-/30-/XX-ST

The SAT command sets the format attributes, which control the way in which data are displayed on the screen. The format attributes are:

underline	– a continuous line under all characters
blinking	– characters displayed/not displayed at a rate of ca. 1.5 Hz
low intensity	– characters are displayed at about 2/3 of normal intensity (in P817-002 terminals operating in bloc mode, these characters are also protected against overwriting from the keyboard, and are not transmitted after a transmit command)
blanking	– characters are stored in the screen memory, but not displayed on the screen.

The required attributes are specified by /XX as the hexadecimal value of the 7-bit character shown below:



A "0" bit sets the required attribute.

RAT RESET ATTRIBUTS code DCS-/31-/XX-ST

The RAT command resets the format attributes, specified by /XX in the same way as described for the SAT command.

NOTE

All format attributes are reset automatically for null codes resulting from the Clear Screen, Insert Line and Delete Line command or keyboard entry, and for the line filled with null codes, which appears on the screen after a roll up.

Software Commands for P817-002

The following software commands are available only for P817-002 terminals:

CHT CURSOR HORIZONTAL TABULATION code CSI-p-/49

The cursor is moved to the first character position of the p-th following unprotected field (default value if p is not specified: p = 1). If the specified position is outside the screen, the cursor is moved to the last character position on the bottom line. If p = 0, the command is ignored.

CBT CURSOR HORIZONTAL BACK TABULATION code-p-/6A

If p =1, the cursor is moved to the first position of the current unprotected field (or to the first position in the preceding unprotected field if it already was in the first position of the current unprotected field). If p >1, the cursor is moved to the first position of the p—th preceding unprotected field. Default value if p is not specified: p =1. If an attempt is made to move the cursor to a position outside the screen, the cursor is moved to the home position. If p = 0, the command is ignored.

CUF CURSOR FORWARD code CSI-p-/43

The cursor is moved to the p-th next character position, or to the end of the line, whichever comes first.
Default value p =1; if p = 0 the command is ignored.

CUB CURSOR BACK code CSI-p-/44

The cursor is moved to the p-th preceding character position, or to the first character position of the line, whichever comes first. Default value p = 1. If p = 0, the command is ignored.

CUU CURSOR UP code CSI-p-/41

The cursor is moved p lines up in the same character position, or to the same character position on the top line, whichever comes first. Default value p = 1. If p = 0, the command is ignored.

CUD CURSOR DOWN code CSI-p-/42

The cursor is moved p lines down in the same character position.
If the p-th line is beyond the bottom line, the cursor remains on the bottom line; if the roll up function is wired, roll ups are executed until the p-th line becomes the bottom line. Default value p = 1; if p = 0 the command is ignored.

IL INSERT LINE code CSI-p-/4C

p lines are inserted at the line on which the cursor is present. The contents of the current line and all following lines are shifted p lines down, and the lower p lines are lost. Default value p = 1; if p = 0, the command is ignored.

DL DEFLETE LINE code CSI-p-/4D

The p lines from the current cursor postion down are deleted; all following lines move p lines up, and p lines with null-characters are added at the bottom of the screen. Default value p = 1; if p = 0 the command is ignored.

ED ERASE IN DISPLAY code SCI-p-/4A

All unprotected characters in the screen area specified by p are replaced by null-characters.
p = 0 specifies the screen area from the current cursor position to the end of the screen.
p = 1 specifies the screen area from the first character on the top line up to the current cursor position.
p = 2 specifies the complete screen.

If p = 0 the cursor remains in the current unprotected field, or the cursor is moved out of the current protected field to the first postion in the next unprotected field.

If p = 1 or p = 2 the cursor is moved to the home position. If the home position is in a protected field, the cursor is moved to the first position in the next unprotected field.

CUP CURSOR POSITION code CSI-p-/3B-n-/48

The cursor is moved to the p-th character position on the n-th line. If either p or n is outside the screen or 0, the command is ignored.

DSR(6) DEVICE STATUS REPORT (6) code CSI-/36-/6E

The terminal is requested to send a cursor position report (see below)

CPR CURSOR POSITION REPORT code CSI-p-/3B-n-/52

The Cursor Position Report sent to the CPU reports that the cursor is in the p-th character position on the n-th line.

FO FAST OUTPUT code CSI-p-/70

The character following this command is repeated p times from the current cursor position, or up to the end of the line, whichever comes first. The cursor remains in position. If the specified character code is non-printable, it is displayed as a white square.

WL WRITE LINE code CSI-p-/3B-n-/3B-x-/71

The string of x characters following this command is written on line n, starting from character position p. If the string is longer than the available line length, all remaining characters are written on the last character position of the line.
If one of the parameters p or n is not specified, specified as 0, or outside the screen (p > 80 or n > 24), it is assumed to be 1. All non-printable characters in the string are displayed as white squares.

RL READ LINE code CSI-p-/3B-n-/3B-x-/72

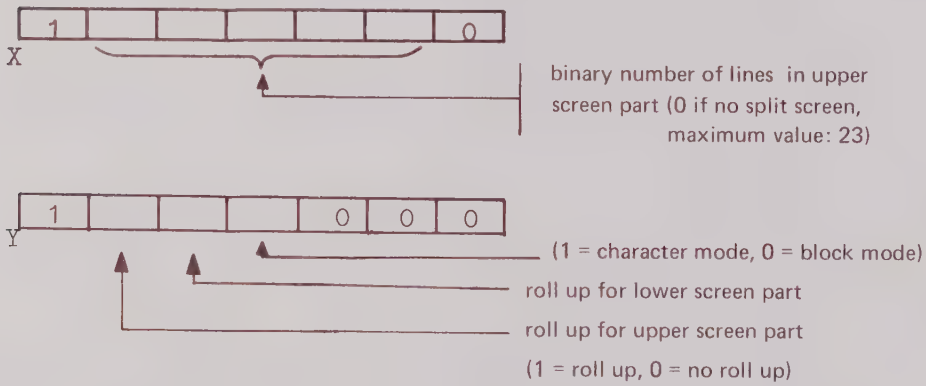
The string of x characters, starting from the p-th character position on line n, is sent from the terminal to the CPU. If the part of the line between the specified character position and the end of the line is shorter than the specified string, only that part of the line is transmitted.
If one of the parameters p or n is not specified, specified as 0, or outside the screen (p > 80 or n > 24) it is assumed to be 1. The character string sent to the CPU is preceded by a Read Line Report (see below).

RLR READ LINE REPORT code ESC-/51

The Read Line Report is sent from the terminal to the CPU preceding the character string requested by a Read Line Command.

WST WRITE STRAPS code DCS-/34-x-y-ST

The WST command is used to change the strap-selectable split screen functions. The new function specification is contained in hexadecimal code in the characters x and y, of which the 7-bit binary value is shown below:


X
1
0
binary number of lines in upper screen part (0 if no split screen, maximum value: 23)
Y
1
0 0 0
(1 = character mode, 0 = block mode)
roll up for lower screen part
roll up for upper screen part
(1 = roll up, 0 = no roll up)

If X or Y is specified with an illegal value, the command is ignored.

RST READ STRAPS code DCS-/35-ST

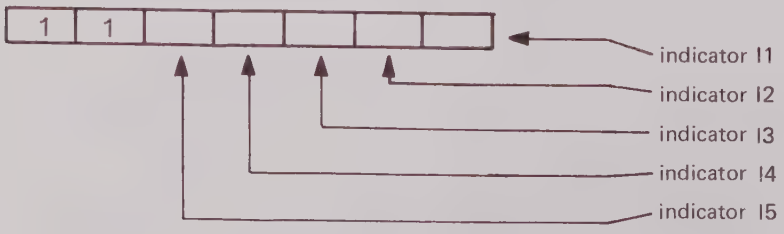
The terminal is requested by CPU to send a Read Straps Report (see below).

RSR READ STRAPS REPORT code DCS-/36-x-y-ST

The Read Straps Report sent to the CPU after a RST command contains the current value of the straps for the split screen and the roll up function for the screen parts and the transfer mode, in the format described for the WST command.

SIND SET INDICATOR code dcs-/32-x-ST

The indicators specified by x are lit. The binary format of x is:



A "0" bit specifies that the indicator must be lit.

RIND RESET INDICATOR code DCS-/33-x-ST

The indicators, specified by a "0" bit in x, in the format described for the SIND command, are extinghuished.

Operators Maintenance

The operators maintenance is restricted to cleaning dirt or smudges from the cabinet using a soft cloth and any commonly used household spray cleaner. The screen faceplate should be cleaned only with a soft damp cloth or tissue to avoid scratching.

All other maintenance should be carried out at regular intervals by a service engineer.

APPENDIX FUNCTION SELECTION STRAPS

The function selection straps in the P817 terminals are located on the logic board inside the display unit. Figure 6 shows the location of the strap groups on the board, figure 7 shows the names and locations of all straps.
Figure 5 shows the strap coding positions; the function described for a strap is selected by putting the strap in the "1" position.

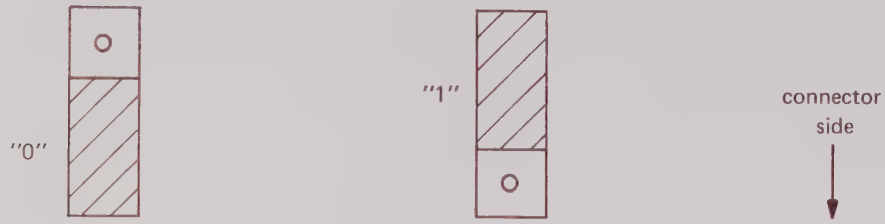


Figure 5. Strap coding positions.

Table 1 contains the names, locations and functions of straps for the P817-001; table 2 contains the same information for the P817-002. For functions which are coded by more than one strap, the coding combinations are given in table 3 (transmission rates), table 4 (parity selection), table 5 (split screen size), table 6 (national versions), and table 7 (delay times for hard copy device).

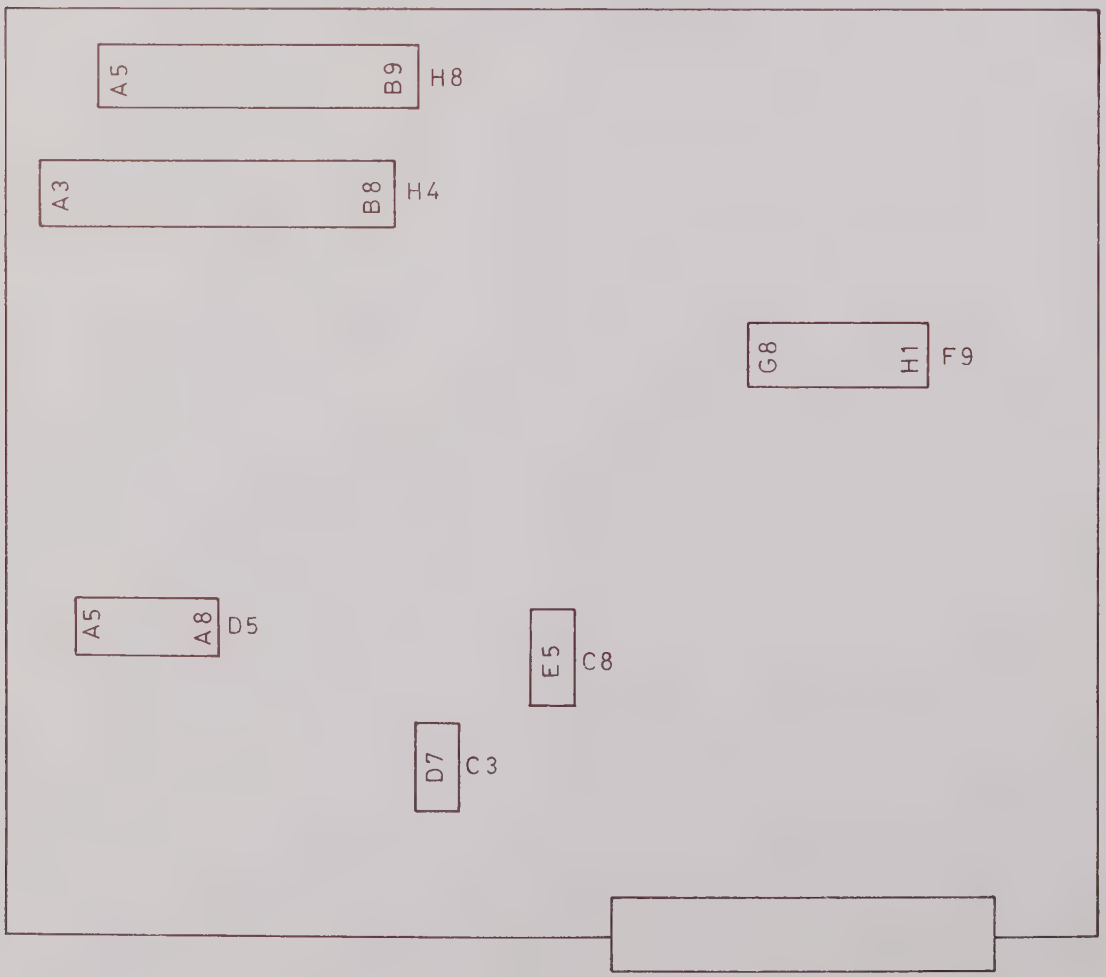


Figure 6. Strap group locations

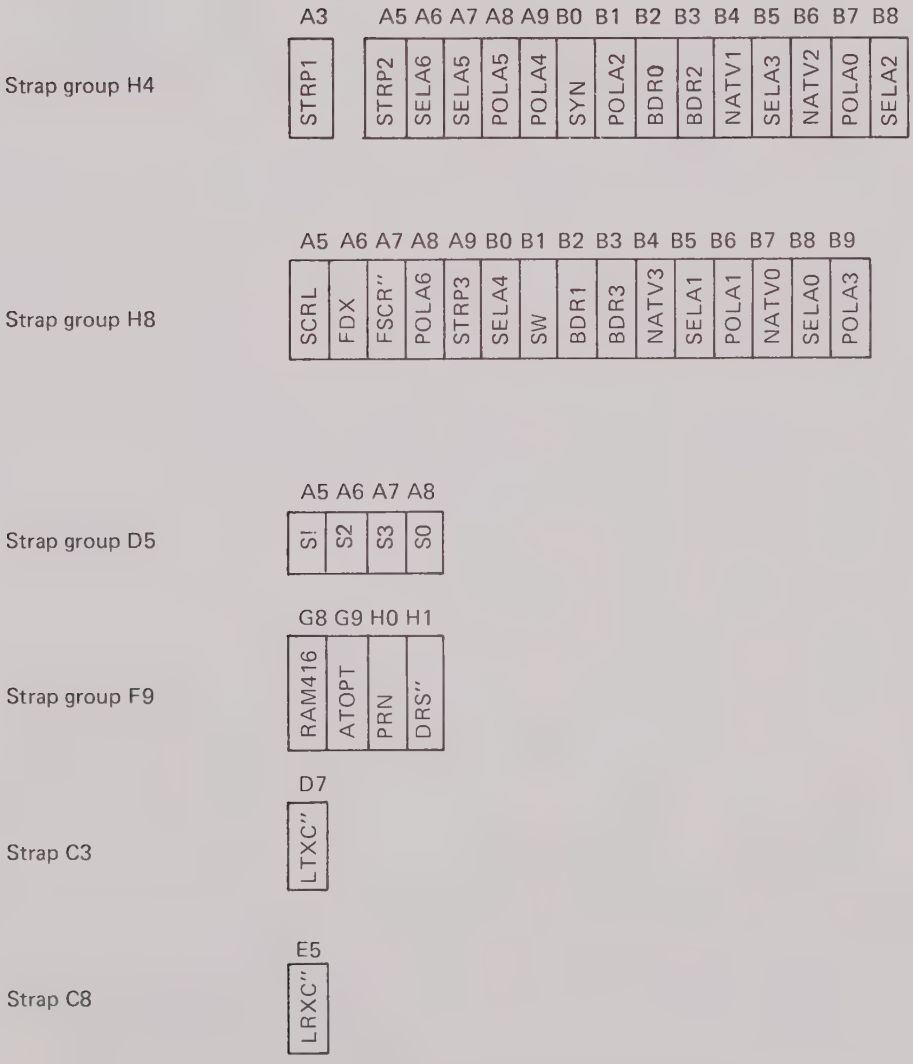

Strap group H4
A3
STRP1
A5 A6 A7 A8 A9 B0 B1 B2 B3 B4 B5 B6 B7 B8
STRP2 SELA6 SELA5 POLA5 POLA4 SYN POLA2 BDR0 BDR2 NATV1 SELA3 NATV2 POLA0 SELA2
Strap group H8
A5 A6 A7 A8 A9 B0 B1 B2 B3 B4 B5 B6 B7 B8 B9
SCRL FDX FSCR'' POLA6 STRP3 SELA4 SW BDR1 BDR3 NATV3 SELA1 POLA1 NATV0 SELA0 POLA3
Strap group D5
A5 A6 A7 A8
S1 S2 S3 S0
Strap group F9
G8 G9 H0 H1
RAM416 ATOPT PRN DRS''
Strap C3
D7
LTXC''
Strap C8
E5
LRXC''

Figure 7. Strap names and positions

strap name	strap position	function
S1	A5D5	transmission rate hard copy device, see table 3
S2	A6D5	
S3	A7D5	
S0	A8D5	
BDR0	B2H4	transmission rate terminal, see table 3
BDR1	B2H8	
BDR2	B3H4	
BDR3	B3H8	
NATV0	B7H8	national versions, see table 6
NATV1	B4H4	
NATV2	B6H4	
NATV3	B4H8	
SELA0	B8H8	echoplex
SELA 1	B5H8	aux. device interface enabled
SELA2	B8H4	parity, see table 4
SELA3	B5H4	not used
SELA4	B0H8	parity, see table 4
SELA5	A7H4	parity, see table 4
SELA6	A6H4	not used
POLA0	B7H4	delay for hard copy device, see table 7
POLA1	B6H8	delay for hard copy device, see table 7
POLA2	B1H4	not used
POLA3	B9H8	delay for hard copy device, see table 7
POLA4	A9H4	not used
POLA5	A8H4	not used
POLA6	A8H8	only upper case to hard copy device
SCRL	A5H8	roll up
SYN	B0H4	not used
SW	B1H8	not used
FDX	A6H8	not used
FSCR"	A7H8	fill screen (service feature)

Table 1. Straps for P817-001

strap name	strap position	function
STRP1	A3H4	not used
STRP2	A5H4	7 bits + even parity to hard copy device
STRP3	A9H8	7 bits + parity to hard copy device
ATOPT	G9F9	attribute options enabled
RAM416	G8F9	always "1"
PRN	H0F9	hard copy device enabled
DRS"	H1F9	CT111 off, in case of double speed modem
LRXC"	E5C8	always "0"
LTXC"	D7C3	always "0"

Table 1. Straps for P817-001 (cont.).

strap name	strap position	function
S1	A5D5	transmission rate hard copy device, see table 3
S2	A6D5	
S3	A7D5	
S0	A8D5	
BDR0	B2H4	transmission rate terminal, see table 3
BDR1	B2H8	
BDR2	B3H4	
BDR3	B3H8	
NATV0	B7H8	national versions, see table 6
NATV1	B4H4	
NATV2	B6H4	
NATV3	B4H8	
SELA0	B8H8	echoplex
SELA1	B5H8	insert line/delete line function inhibited if roll up function not wired
SELA2	B8H4	parity, see table 4
SELA3	B5H4	character mode
SELA4	B0H8	parity, see table 4
SELA5	A7H4	parity, see table 4
SELA6	A6H4	only upper case to hard copy device
POLA0	B7H4	
POLA1	B6H8	number of lines in upper screen part, see table 5
POLA2	B1H4	
POLA3	B9H8	
POLA4	A9H4	
POLA5	A8H4	roll up lower screen part
POLA6	A8H8	roll up upper screen part
SCRL	A5H8	split screen
SYN	B0H4	delay for hard copy device, "1" = 1100 msec, "0" = 200 msec.
SW	B1H8	hard copy device enabled
FDX	A6H8	full duplex

Table 2. Straps for P817-002.

strap name	strap position	function
FSCR"	A7H8	fill screen (service feature)
STRP1	A3H4	2 stop bits
STRP2	A5H4	7 bits + even parity to hard copy device
STRP3	A9H8	7 bits + parity to hard copy device
ATOPT	G9F9	attribute options enabled
RAM416	G8F9	always "1"
PRN	H0F9	hard copy device enabled
DRS"	H1F9	CT111 off, in case of double speed modem
LRXC"	E5C8	always "0"
LTXC"	D7C3	ALWAYS "0"

Table 2. Straps for P817-002 (cont.).

strap name	BDR3	BDR2	BDR1	BDR0
strap position	B3H8	B3H4	B2H8	B2H4
50	0	0	1	0
75	0	0	1	1
110	1	1	1	1
134.5	0	1	0	0
150	1	1	1	0
200	0	1	0	1
300	1	1	0	1
600	0	1	1	0
1200	1	0	1	1
1800	1	0	1	0
2400	0	1	1	1
2400	1	1	0	0
4800	1	0	0	1
9600	1	0	0	0

Table 3. Transmission rates (in baud).

strap name		SELA 4	SELA5	SELA2
strap position		B0H8	A7H4	B8H4
no. of bits	parity			
7	none	0	0	0
7	none	0	1	0
7	odd	1	0	0
7	even	1	1	0
8	fixed 0	0	0	1
8	fixed 1	0	1	1

Table 4. Parity.

strap name	POLA4	POLA3	POLA2	POLA1	POLA0
strap position	A9H4	B9H8	B1H4	B6H8	B7H4
no split screen	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1

Table 5. Split screen size (number of lines in upper screen part).

strap name	NATV3	NATV2	NATV1	NATV0	
strap position	B4H8	B6H4	B4H4	B7H8	
GERMANY	0	0	0	0	
NETHERLANDS	0	0	0	1	
GR. BRITAIN	0	0	0	1	
FRANCE	0	0	1	0	national
ITALY	0	1	0	0	versions
SWEDEN I	0	1	0	1	group I
SWEDEN II	1	0	0	1	
DENMARK	0	1	1	0	
SPAIN	0	0	1	1	
YUGOSLAVIA	0	1	0	1	national
PORTUGAL	0	1	1	1	versions
U.S.A.	1	0	0	0	group II

Table 6. National versions of character set.

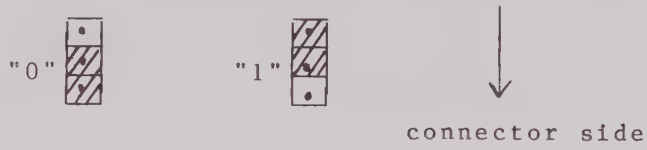
strap name	POLA3	POLA1	POLA0
strap position	B9H8	B6H8	B7H4
no delay	0	0	0
100 msec	0	0	1
200 msec	0	1	0
300 msec	0	1	1
800 msec	1	0	0
900 msec	1	0	1
1000 msec	1	1	0
1100 msec	1	1	1

Table 7. Delay times for hard copy device.

ADJUSTMENT PROCEDURE FOR LOGIC BOARD CRD1 DISPLAY TYPE P817-002
****

1. General.

All adjustments mentioned are done on logic board CRD1.
A "0" for a strap means lower position, a "1" means upper position.



2. PROM locations.

Note: The 2K PROM type 82S184 cannot be used on the CRD1 board (escape PROM used on CRB1 board).

2.1. PROM location National Version Group 1.
(Germany/Gr.Britain/France/Italy/Sweden/Sweden ind./Denmark)

Location	2K-PROMs (82S185)		1K-PROMs (82S137)
G1G5			30731
F7G5	94261	or	30711
F2G5	94271		30721
E8G5			30741

2.2. PROM location National Version Group 2.
(Spain/Portugal/Yugoslavia/U.S.A.)

Location	2K-PROMs (82S185)		1K-PROMs (82S137)
G1G5			30771
F7G5	94241	or	30751
F2G5	94251		30761
E8G5			30781

2.3. PROM location National Version Group 3.
(Saudi Arabie)

Location	2K-PROMs (82S185)	1K-PROMs (82S137)
G1G5		
F7G5	96041	N.U.
F2G5	96051	
E8G5		

2.4. PROM location National Version Group 4.

N.U. for P817-002

2.5. PROM location program PROMs for P817-002

Note: normally there will used or 2K PROMs or 1K PROMs.
It is possible that 2K and 1K types are mixed up
but they have then the same release.
NEVER USE TWO DIFFERENT RELEASES ON ONE BOARD.

Location	2K-PROMs (82S185) release 002	1K-PROMs (82S137) release 003 (not yet available)
A5H6	96161	
A9H6		
B3H6	96171	
B7H6		
C1H6	96181	
C5H6		
C9H6	96191	
D4H6		
D8H6	96201	
E2H6		
E6H6	96211	
F0H6		
* F4H6		
F9H6		
* G3H6		
G7H6		
H1H6		
H5H6		
H9H6		
I3H6		

* Splitscreen option release 002

PROM 1K (82S137) 96221 on location F4H6
PROM 1K (82S137) 96231 on location G3H6

3. Baudrate.

3.1. Transmission rate.

By means of the straps BDR0 ,BDR1 ,BDR2 and BDR3 the next baudrates can be adjusted.

Name Strap location	BDR0 B8A3	BDR1 B7A3	BDR2 B6A3	BDR3 B5A3	baud rate
	0	1	0	0	50 bps
	1	1	0	0	75
	0	0	1	0	134,5
	1	0	1	0	200
	0	1	1	0	600
	1	1	1	0	2400
	0	0	0	1	9600
	1	0	0	1	4800
	0	1	0	1	1800
	1	1	0	1	1200
	0	0	1	1	2400
	1	0	1	1	300
	0	1	1	1	150
	1	1	1	1	110

3.2 Baudrate selection for aux. hard copy printer.(if present)

By means of the straps S0 ,S1 ,S2 and S3 the baudrate for the hard-copy device can be adjusted.

Name Strap location	S0 I2D0	S1 I1D0	S2 I0D0	S3 H9D0	baud rate
	0	1	0	0	50 bps
	1	1	0	0	75
	0	0	1	0	134,5
	1	0	1	0	200
	0	1	1	0	600
	1	1	1	0	2400
	0	0	0	1	9600
	1	0	0	1	4800
	0	1	0	1	1800
	1	1	0	1	1200
	0	0	1	1	2400
	1	0	1	1	300
	0	1	1	1	150
	1	1	1	1	110

4. National version.

If the PROMs for the national versions are installed, the next selections per group are possible by means of the straps NATV0, NATV1, NATV2 and NATV3.

4.1 Group 1

Strap name / location	NATV3 B5A7	NATV2 B6A7	NATV1 B7A7	NATV0 B8A7
Country				
Germany	0	0	0	0
Gr.Britain	0	0	0	1
Netherlands	0	0	0	1
France	0	0	1	0
Italy	0	1	0	0
Sweden 1	0	1	1	0
Denmark	0	1	1	0
Sweden 2	1	0	0	1

4.2 Group 2

Spain	0	0	1	1
Yugoslavia	0	1	0	1
Portugal	0	1	1	1
U.S.A.	1	0	0	0

4.3 Group 3

Saudi Arabie	1	0	0	0

4.4 Group 4

N.U. for P817-002

5. Transmission mode.

strap	position	value	function
FDX	A4A3	"0"	Half Duplex (block mode only)
		"1"	Full Duplex
SELA0	B3A3	"0"	No Echoplex
		"1"	Echoplex (char.mode only)
SELA3	B0A3	"0"	Block mode
		"1"	Character mode
STRP1	C1A7	"0"	1 stopbit to line
		"1"	2 stopbits to line

The parity on the line-interface can be strapped according to next table:

Strap name	SELA4	SELA5	SELA2
Position	A9A3	A8A3	B1A3
No parity, 7 bits	0	0	0
Fixed "0", 8 bits	0	0	1
No parity, 7 bits	0	1	0
Fixed "1", 8 bits	0	1	1
Odd parity, 7 bits	1	0	0
Not used	1	0	1
Even parity, 7 bits	1	1	0
Not used	1	1	1

6. Functional Straps.

strap FSCR on location A5A7
"0" normal operation
"1" complete screen is filled with characters as coded by
POLA0 - POLA6 straps. (POLA6 is most significant bit).

note: only the codes /20 - /7F are valid.

strap name	POLA0	POLA1	POLA2	POLA3	POLA4	POLA5	POLA6
position	B3A7	B2A7	B1A7	B0A7	A9A7	A8A7	A7A7

attention: The straps POLA0 - POLA6 have also other functions.
If no option split screen is installed:

POLA6 on A7A7 "0" no ROLL-UP
"1" ROLL-UP

SELA1 on B2A3 "0" INSERT-DELETE LINE enable
"1" INSERT-DELETE LINE disable only if ROLL-UP is disabled.

RAM416 on E0F6 "1" (always)

ATOPT on E6F6 "0" no attributes (blinking/blanking/underline)

PRN on E4F6 "0" no hard-copy

SCRL on A3A3 "0" no splitscreen

SW on A5A3 "0" no hard-copy

LRXC" on E3F6 "0" (always)

LTXC" on E2F6 "0" (always)

PROM12 on E1F6 "0" (always)

DRS" on E5F6 "0" CT111=ON (only used in case of
"1" CT111=OFF double speed modems)

7. OPTIONS.
To install option F1 (hardcopy plus attributes), place circuits on positions E9C0 and H5C5 for hardcopy and for the attributes on positions A2H0, A2G5 and A2G0 (underline, blinking and blanking).

ATOPT on E6F6 "1" attributes enabled.

PRN on E4F6 "1" hardcopy enabled.

SW on A5A3 "1" hardcopy enabled.

STRP3 on C3A7 "0" 7 bits, no parity to auxillary.
"1" 7 bits and parity to auxillary.

STRP2 on C2A7 "0" Odd parity to auxillary.
"1" Even parity to auxillary.

SYN on C0A7 "0" 200 msec delay after CR-LF to printer.
"1" 1100 msec delay after CR-LF to printer.

For PER 3135 printer interface SYN="0" for 300 baud.
SYN="1" for 600 baud.

SELA6 on A7A3 "0" upper and lower case to printer.
"1" lower case converted to upper case.

for baudrate aux printer see page 3 (straps S0 - S3)

SCRL on A3A3 "1" splitscreen enabled

With the straps POLA0 - POLA4 the number of lines in upper screen part can be adjusted. (max 23 lines).

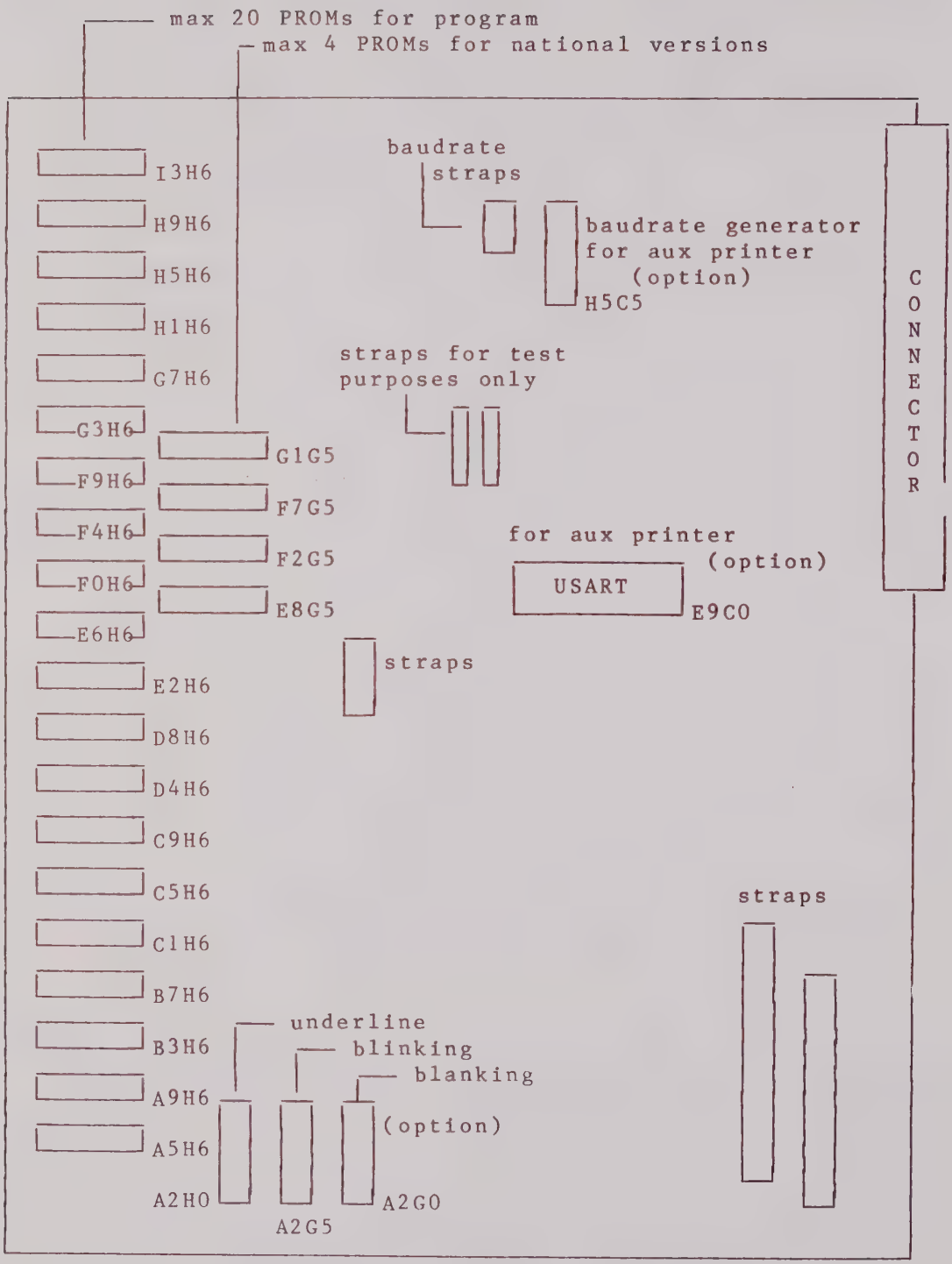
Strap name position	POLA4 A9A7	POLA3 B0A7	POLA2 B1A7	POLA1 B2A7	POLA0 B3A7	number of lines in upper screen part
	0	0	0	0	0	0 lines (no spl.scr.)
	0	0	0	0	1	1 line
	-	-	-	-	-	-
	1	0	1	1	1	23 lines

Higher binary values are not valid.

POLA5 on A8A7 "0" no Roll-up in lower-part
"1" Roll-up in lower-part

POLA6 on A7A7 "0" no Roll-up in upper-part
"1" Roll-up in upper-part

note: If SELA1 is "1" insert and delete line is disabled in any part with no Roll-up.



Positions PROMS and OPTIONS on board CRD1

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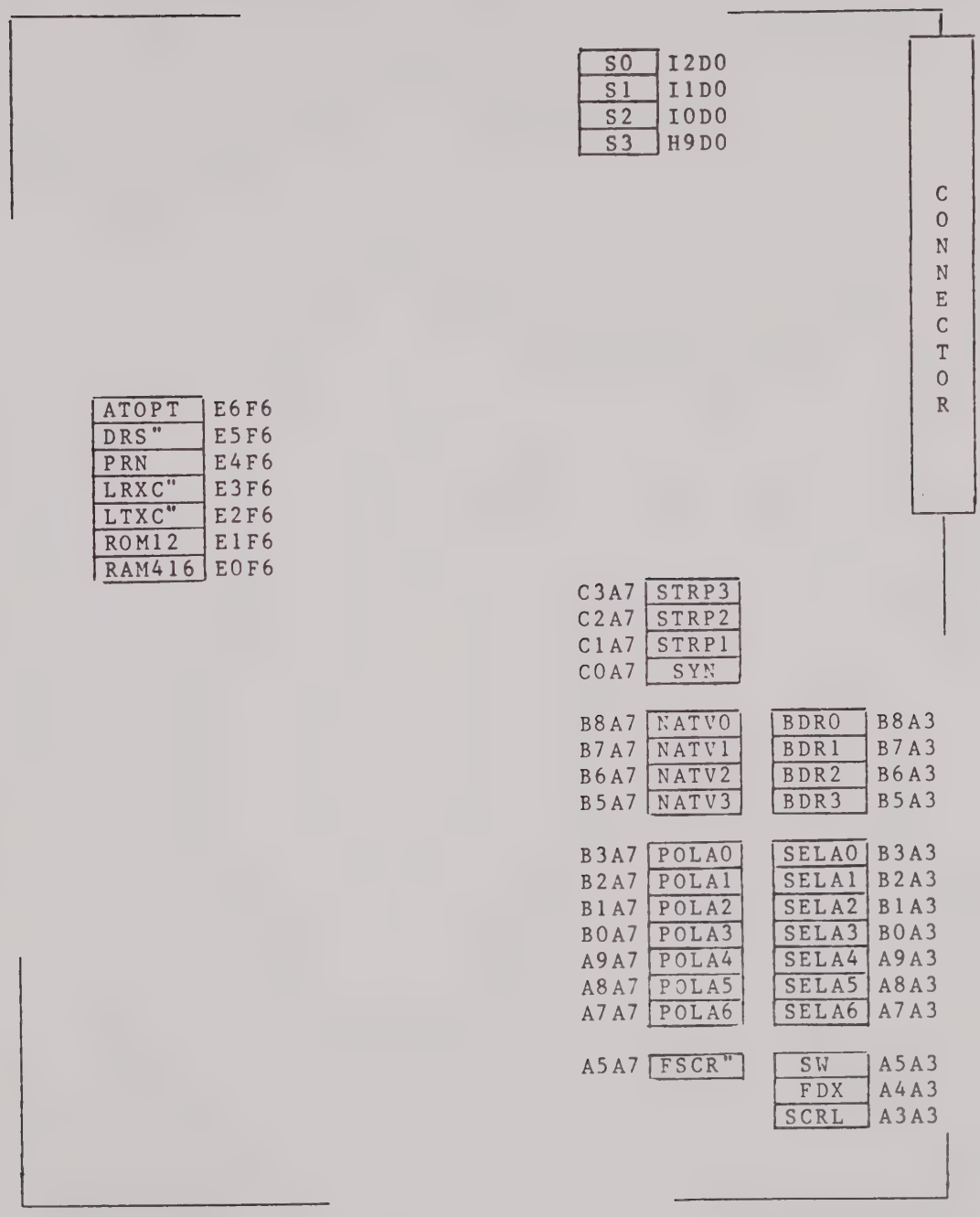
for positions of straps see page 9



Strap positions on board CRD1

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P817-2
sheet 9 of 9

Manual 368
Issue 3, March 1978

APPENDIX B

THE 43 TELEPRINTER

Installation & Routine Servicing

for

BASIC KSR TERMINALS

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THE 43 TELEPRINTER
BASIC KSR
INSTALLATION AND ROUTINE SERVICING MANUAL

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THE 43 TELEPRINTER
BASIC KSR
INSTALLATION AND ROUTINE SERVICING MANUAL

PART 1 -- INTRODUCTION

This manual provides information on the installation and routine servicing of the 43 Teleprinter Basic KSR Terminals. Instructions are provided for service personnel, with a minimum of training, tools and spare parts, to enable variable features, connect the proper interface, correct minor troubles and periodically inspect, lubricate and clean the terminal during extended service intervals.

These 43 Teleprinter Basic KSR Terminals provide character at a time keyboard-printer send-receive operation using 12-inch wide sprocket feed paper or 8-1/2-inch wide friction feed paper. Transmission speeds are attendant controlled at 100 or 300 characters per second on terminals equipped with either an internal modem or with one of two types of digital communications interfaces.†

Terminals with an internal modem for data transmission, interface electrically with the telephone switched network and with a modular jack telephone for originating calls and talking. Terminals with digital interfaces are furnished to operate on EIA voltage levels, or on TTL voltage levels, and exchange data and control signals with external modems or other devices for communication over switched or private lines.

Information on how to check proper operation, change the ribbon cartridge and install paper is included in the How To Operate Manual 367 furnished with each terminal.

Note: When ordering replaceable components, prefix each part number with the letters "TP" (ie, TP129534), unless specified otherwise.

Tools and spare parts that may be required are as follows:

DESCRIPTION	TELETYPE CORP. PART NO.
3/16" and 1/4" Open-End Wrench	129534
1/4", 6" Blade, Screwdriver	100982
1/16" Allen Wrench	124682
1.0 A SLO-BLO Fuse	143306
1.0 A Fuse	120139
Lubricants	See Page 3-5

In the event that troubles occur that cannot be corrected with the information in this manual, refer to the applicable 43 Teleprinter Manuals: Repair Manual 391, Service Manual 369, and Circuit Diagrams Manual 385 (can be purchased from Teletype Corporation), replace the terminal, or contact the nearest Teletype Product Service Center.

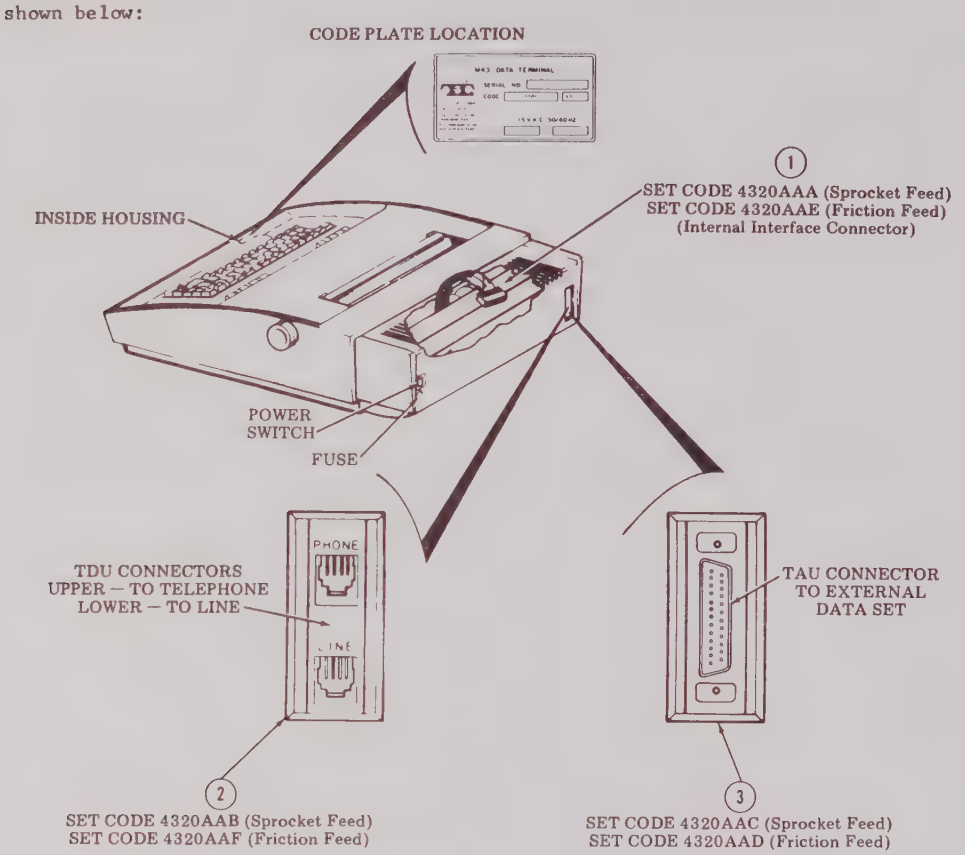
†Digital Interfaces: (Teletype Corporation Technical Reference for 43 Teleprinter Basic KSR Terminals).

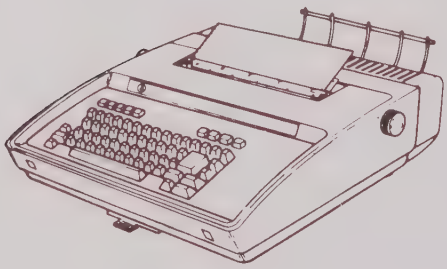
EIA -- Electronics Industries Association (Spec RS-232C) +25 V dc to -25 V dc (On-Off Range)

TTL -- Transistor Logic 0 V dc to +5 V dc (On-Off Range)

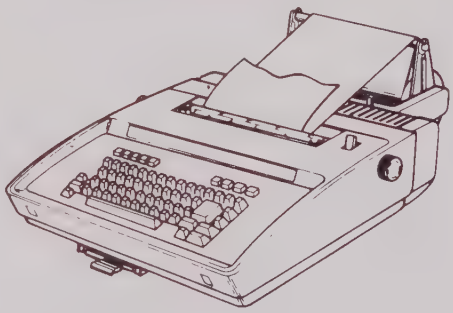
PART 1 -- INTRODUCTION (Cont)

The three types of interfaces and the six basic KSR sets can be identified as shown below:





KSR (Sprocket Feed)



KSR (Friction Feed)

PART 2 -- INSTALLATION
A. VARIABLE FEATURES

The chart below provides information on how to set the feature shown under feature numbers 431 through 435. Record any nonstandard options enabled in the space provided on the directory card (bottom side).

Feature No. | Feature Suffix and Conditions | Feature Definition | Switch Numbers | Location of Switch on Circuit Card (See Page 3-8)

XXX	SPD4 1	2	3	4	5	6	7	8	
a.	—	—	—	—	○	●	—	—	*
b.	—	—	—	—	○	●	—	—	

431. Type Font Arrangement	SPD4 1	2	3	4	5	6	7	8	
a. Narrow numeric 0 and wide alpha O. Standard ∧ and underline _ .	—	—	—	—	—	—	●	●	*
b. Slash numeric Ø and wide alpha O. ∧ prints as ↑ and _ prints as ←.	—	—	—	—	—	—	●	○	
c. Slash alpha Ø and wide numeric O. ∧ prints as ↑ and _ prints as ←.	—	—	—	—	—	—	○	○	

432. Line Length	SPD4 1	2	3	4	5	6	7	8	
a. 132 Characters (Sprocket Feed Only)	—	—	—	—	●	●	—	—	‡
b. 72 Characters — Printed line not centered.	—	—	—	—	○	●	—	—	*
c. 80 Characters	—	—	—	—	○	○	—	—	‡
d. 72 Characters — Printed line centered (Friction Feed Only) §	—	—	—	—	○	●	—	—	

433. EOT Response	SPD4 1	2	3	4	5	6	7	8	
a. Disconnect or turn off Term Ready on received EOT.	—	—	—	○	—	—	—	—	*
b. Does not disconnect or turn off Term Ready on received EOT.	—	—	—	●	—	—	—	—	

434. Character Parity Bit Sent	SPD4 1	2	3	4	5	6	7	8	
a. Even Parity	—	—	○	—	—	—	—	—	*
b. 8th Bit Mark	—	—	●	—	—	—	—	—	

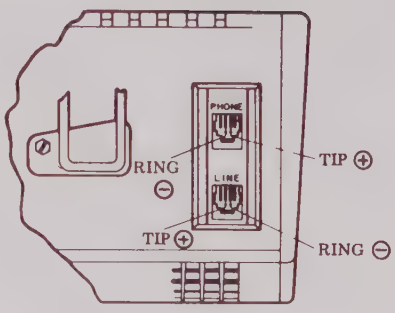
435. End-of-Line on Receive	SPD4 1	2	3	4	5	6	7	8	
a. Auto CR-LF performed	○	—	—	—	—	—	—	—	*
b. Bell & Print Inhibit at last char. position	●	—	—	—	—	—	—	—	

● Indicates toggle or slide position to ON.
○ Indicates toggle or slide position to OFF.
— Position of switch does not affect feature.
* Factory furnished state of feature.

‡ On friction feed terminals, 432c (80 Characters) is factory furnished. 432a (132 Characters) should not be selected.
§ LEFT-HAND MARGIN adjustment must be performed (See Page 3-10).

PART 2 -- INSTALLATION (Cont)
B. INTERFACES (Cont)

The 4320AAB and AAF sets equipped with 430750 Terminal Data Unit (TDU) provide two modular telephone jacks for connection to the telephone equipment using modular cords. These jacks are labeled line (bottom) and phone (top) and the pin assignments are as shown:



The 4320AAC and AAD sets equipped with a 430751 Terminal Auxiliary Unit (TAU) provide a 25-pin male connector for connection to an external communications device (modem) or distant terminal. The interface meets the requirements of EIA - RS-232C. (See Page 2-6 for cables available from Teletype Corporation.) The pin assignments are given below:

EIA DATA SET INTERFACE SIGNALS

Connector Pin	Signal	EIA Circuit Designation	Status
1	Protective Ground	AA	Not Wired in TAU or Recommended Cable
2	Transmit Data	BA	Active
3	Receive Data	BB	Active
4	Request to Send	RS	Always Off (Issue 1B Logic Card) -- Always On (Issue 2A Logic Card)
5	Clear to Send	CB	Active
6	Data Set Ready	CC	Active
7	Signal Ground	AB	Active
8	Received Line Signal Detector	CF	Active
9			Not Wired in TAU or Recommended Cable
10			Not Wired in TAU or Recommended Cable
11	TWX Control	-	Not Applicable
12	Data Speed Indicator	SCF	Not Applicable
13			Not Wired in TAU or Recommended Cable
14			Not Wired in TAU or Recommended Cable
15			Not Wired in TAU
16			Not Wired in TAU or Recommended Cable
17			Not Wired in TAU
18	TWX Indicator	-	Not Applicable, Not Wired in Recommended Cable
19			Not Wired in TAU or Recommended Cable
20	Data Terminal Ready	CD	Active
21			Not Wired in TAU or Recommended Cable
22			Not Wired in TAU or Recommended Cable
23	Data Speed Select	CH	Always Off
24			Not Wired in TAU or Recommended Cable
25	Analog Loop Test		Active

The 4320AAA and AAE sets are furnished without the interface signaling unit. Connection to the external communications device (provided by the customer) is made through a 20-pin connector, Berg 65346-003 or 3M 3421-300 or equivalent at the end of a short ribbon cable. No provision is made for adding additional cable length.

Electrical Characteristics of Interface Leads are:

Electrical signals compatible with low-power TTL logic are utilized for both control and data interchange as described below:

STATE	DRIVER	TERMINATOR
MARK (OFF) (1)	$+2.4 \leq V_{MARK} \leq +5.25$ Volts	$+2.0 \leq V_{MARK} \leq +5.25$ Volts
SPACE (ON) (0)	$0 \leq V_{SPACE} \leq +0.4$ Volts	$0 \leq V_{SPACE} \leq +0.7$ Volts

TTL PIN ASSIGNMENT CHART

Pin No.	Code	Function	Status
1	DL	Digital Loop Test	Active
2	DSI	Data Speed Indicator to Terminal	Not Applicable, Not Wired in TTL Cable
3	AL	Analog Loop Test	Active
4	DSS	Data Speed Select from Terminal	Not Applicable, Not Wired in TTL Cable
5	TR	Terminal Ready	Active
6	RS	Request to Send	Not Connected, Always Off (Issue 1B Logic Card) -- Always On (Issue 2A Logic Card)
7	+5	+5 Volts	Active
8		Reserved for future	Not Applicable, Not Wired in TTL Cable
9	GND	Circuit Ground	Active
10		Reserved for future	Not Applicable, Not Wired in TTL Cable
11	-12	-12 Volts	Active
12		Reserved for future	Not Applicable, Not Wired in TTL Cable
13	+12	+12 Volts	Active
14	DP	Duplex Indicator from Terminal	Not Applicable, Is Wired in TTL Cable
15	DR	Data Ready	Active
16	TW2	TWX Indicator	Not Applicable, Not Wired in TTL Cable
17	RD	Receive Data	Active
18	TW1	TWX Control	Not Applicable, Not Wired in TTL Cable
19	SD	Transmit Data	Active
20		Reserved for future	Not Applicable, Not Wired in TTL Cable

PART 2 -- INSTALLATION (Cont)
C. ASSEMBLY

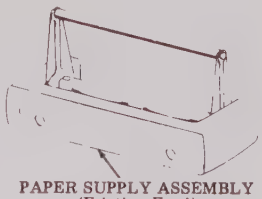
The basic 43 Teleprinter set is furnished fully assembled and tested with one of the signal interfaces described on Page 2-2, B. INTERFACES.

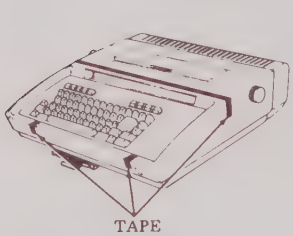
CAUTION: To avoid condensation on the electrical components, the terminal should be allowed to assume room temperature before unpacking, for example, when brought into a warm humid room from outside subzero temperatures.

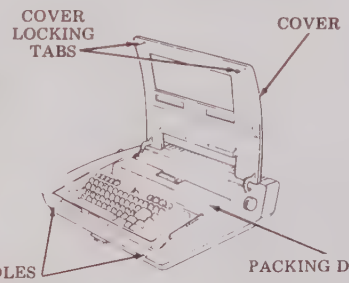
1. UNPACKING

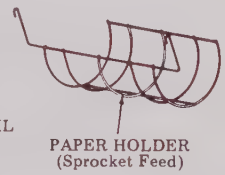
a. Unpack the large carton referring to instructions on the container.
b. Remove tape securing the cover to the housing (see below).
c. Depress the cover locking tabs on the lower front of the cabinet and lift the cover. Remove the packing detail securing the print head (see below).
d. Verify that the following items are included in the box:

1 - Set -- 43 Teleprinter (4320AAA, AAB, AAC, AAD, AAE or AAF)
1 - Ribbon
1 - Manual, Installation and Routine Servicing, 368
1 - Manual, Attendant, 367
1 - Paper Holder (Sprocket Feed Only)
1 - Paper Supply Assembly (Friction Feed Only)







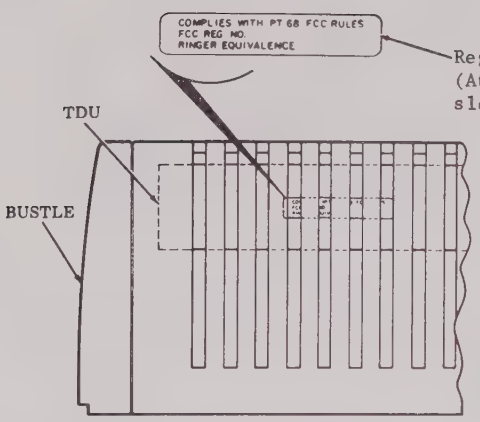


NOTE: Fan-fold 12 by 8-1/2 inch paper (sprocket feed), 8-1/2 inch wide by 5 inch diameter rolls (friction feed) and EIA and modular telephone cords must be obtained locally or ordered separately. Refer to HTO for paper suppliers. EIA and modular telephone cords can be ordered from Teletype Corporation (see Page 2-6).

2. TELEPHONE AND LINE CONNECTION

NOTICE: In the U.S.A., under the FCC registration program, the 43 Teleprinters with 430750 terminal data units (TDU) may be connected directly to the telephone switched network subject to the following conditions:

a. Connection must be through a standard six-pin miniature jack (USOC RJ11C) installed by the Telephone Company.
b. The telephone, if any is to be connected to the teleprinter, must be registered or grandfathered (Bell System 500 or 2500 type or equivalent) and be reported as such to the local Telephone Company.



Registration Tag on Registered Terminals (Attached to TDU and readable through slots in bustle.)

Left Rear Corner of 43 Teleprinter

USOC RJ11C Jack

c. Before connection or reconnection to the switched network, the local Telephone Company must be advised of the following:

Registered Terminals Only (With Registration Tag)	Grandfathered Terminals Only (No Registration Tag)*
(1) Registration Number (from tag)	(1) Teleprinter model number 4310 (RO) or 4320 (KSR) with suffix AAB (sprocket feed) or AAF (friction feed). Includes built-in Western Electric 153A1 modem (TDU).
(2) Ringer Equivalence (from tag)	(2) Telephone number where terminal will be connected.
(3) Telephone number where terminal will be connected.	(3) Ringer Equivalence: 0.3
	(4) Ringer Type: A
	(5) Voice baud metallic signal power: Nonadjustable -9 dbm max.
	(6) Baud Rate: 300 max.

*First time connection must take place before July 1, 1979. The teleprinter may remain connected and be reconnected for its life.

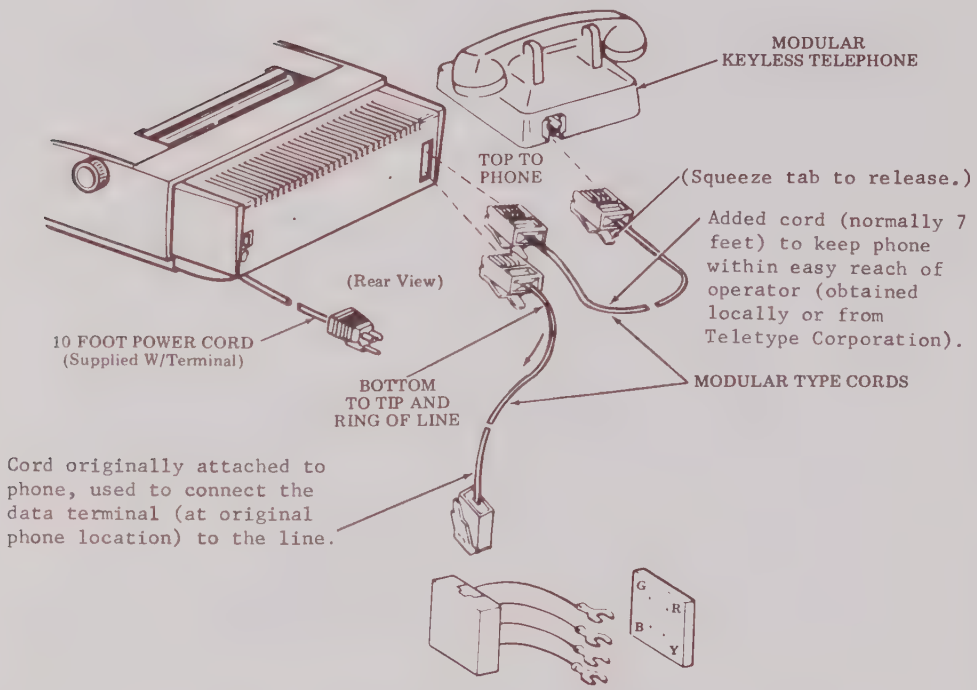
● Refer to Manual 407 for additional registration instructions.

4320AAB and AAF Sets With TDU

a. Remove the modular cord plug from the modular jack associated with the keyless telephone to be used with the teleprinter (squeeze tab to release). Connect the plug to the lower connector marked LINE on the rear of the TDU accessible through the opening in the left rear of the bustle cover (Page 2-6).
b. Connect the additional modular cord between the upper connector on the TDU marked PHONE and the telephone jack (Page 2-6).

c. The modular telephone cord connected between the upper connector on the TDU and the telephone jack must be furnished by the installer. The following cables are available from Teletype Corporation.

7 foot length	430581
14 foot length	430582
25 foot length	430583



Telephone Connection (Set W/TDU)

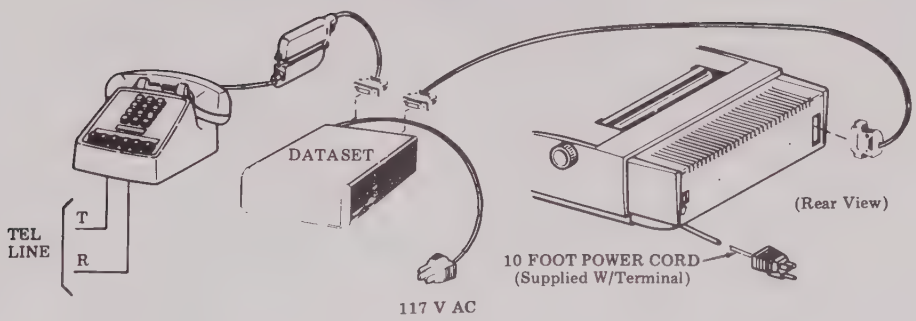
4320AAC Set With TAU

a. The connecting cables between the terminal and the data set must be furnished by the installer and should employ shielded cable. The following cables are available from Teletype Corporation.

7 foot length	408065
12 foot length	408066
25 foot length	408067
50 foot length	408068

b. The connection to the data set and telephone should be made following the instructions for the particular data set involved (Page 2-7).

PART 2 -- INSTALLATION (Cont)
C. ASSEMBLY (Cont)



Telephone Connection (Set W/TAU)

4320AAA and AAE Sets Without Interface Signaling Unit

Connection to the 43 Teleprinter interface cable requires the removal of the paper holder or paper supply assembly, paper deflector (if present) and bustle cover. Refer to Page 3-8, C. COMPONENT ACCESS for removal instructions.

This set is not equipped with a communications unit and telephone and line connections cannot be made until the KSR set is provided with an appropriate communications device. The connections to the telephone, data set or communications device should be done following the instructions for the particular device involved.

3. ACCESSORIES

a. Install the ribbon and paper. Refer to Manual 367.
b. Install the friction feed paper supply assembly or the sprocket feed paper holder, if desired. If the paper holder is not installed, provide to attendant for possible future use. Refer to Page 3-8.
c. Record any nonstandard options enabled in the space provided on the directory card. (Write in any not listed on card.)
d. Fill out remaining information on the directory card in accordance with local procedures, (ie, provide attendant with HTO manual, ribbon ordering form, etc).
e. Install the directory card in the holder provided, "Frequently Called Numbers" side up. Refer to Page 3-8.

4. STATION TESTING

After installation, the station shall perform as stated in the How To Operate Manual 367.

PART 3 -- ROUTINE SERVICING
A. TROUBLE ISOLATION AND CORRECTION

QUESTIONS	YES	NO
1. Are any of the three communications mode keys lit? (Power available and set power on.) (Depress other keys if proper key not lit.)	Go to 2.	Go to 1a.
1a. Is there any indication of power in the set? (Lamps flash when power is turned on and off, red lamp on power supply, etc). (See Page 3-8.)	Go to 1b.	Check and replace set fuse (F1) if blown. Trouble is in terminal if fuse blows again. If not blown go to 1b.
1b. Is red lamp on power supply lit?	Check opcon cable connector. (See Page 3-8.)	Check fuse (F2) on power supply. If blown, check for foreign objects between circuit lands or terminals and replace fuse. Trouble is in terminal if fuse blows again.
2. Does printer print test message while the PRINTER TEST key is depressed? (ie, character set printed repeatedly within margin restraints.)	Go to 2a.	Turn off power for several seconds and retry. Trouble is in terminal.
2a. Are any of the following characters substituted in copy? O Ø ^ ↑ — ←	Check Page 2-1, A. VARIABLE FEATURES, 431.	Go to 2b.
2b. Are undesired line lengths set as follows when power is turned on? 72 80 132	Check Page 2-1, A. VARIABLE FEATURES, 432.	Go to 2c.

PART 3 -- ROUTINE SERVICING (Cont)
A. TROUBLE ISOLATION AND CORRECTION (Cont)

QUESTIONS	YES	NO
2c. Is printed copy properly centered or aligned with edges of paper? Sprocket Feed - Parallel to edge and not printing on fold or form line. Friction Feed - Properly centered on roll paper.	Go to 2d.	Sprocket Feed - Check Right Paper Sprocket adjustment and Printed Line adjustment. (See Page 3-9.) Friction Feed - Check Left-Hand Margin adjustment. (See Page 3-10.)
2d. Is print density acceptable (including any carbons)?	Go to 3.	Replace ribbon. Check proper density multicopy paper.
3. Are data messages properly sent and received in DATA mode?	Go to 4.	Go to 3a.
3a. Do PARITY, DUPLEX and CPS keys alternately lock down and release up when depressed?	Go to 3b.	Trouble is in terminal.
3b. Does substitute character ■ appear with PARITY key on?	Go to 3c.	Go to 4.
3c. Are both stations operating at same speed, is local copy obtained and is remote station sending even parity?	Go to 4.	Select proper speed and DUPLEX keys. Operate with PARITY switch off or check Page 2-1, A. VARIABLE FEATURES, 434 if remote station is printing the ■ character.
4. Does terminal have a directly connected modular telephone?	Go to 5.	On-line communications troubles encountered using externally connected data sets and telephones or other arrangements may be isolated by observing signals at the EIA or TTL interface connector. See Page 2-2, B. INTERFACES.
5. Does AUTO ANSW key light when power is turned on and do LOCAL-TALK, AUTO ANSW and DATA keys each light when depressed?	Go to 6.	Trouble is in terminal.

QUESTIONS	YES	NO
6. Does telephone operate normally with LOCAL-TALK key lit?	Go to 7.	Check proper connection of modular cords at rear of set. See Page 2-2, B. INTERFACES. Connect phone directly to line. Go to 6a.
6a. Does phone now operate normally?	Check cord that was between phone and terminal. If OK, trouble is in terminal.	Check connections to line and cord between phone and line. Replace phone.
7. When originating a call (answering tone heard) and DATA key depressed, does DATA key light steadily?	Go to 8	Go to 9.
8. Does phone ring only once and the DATA key light following a received call in the AUTO ANSW mode?	Go to 9.	Originating station must send originating frequency tones, ie, go to DATA mode. If OK, trouble is in terminal.
9. Does station echo-back characters (print twice) in ANALOG LOOPBACK -- HALF DUPLEX mode? (ie, depress AUTO ANSW key, ESC key and shifted > key.) (Alarm lamp flashes.)	Remote station may be sending incorrect frequencies or signal levels.	Trouble is in terminal.
10. Does carriage return automatically when line lengths beyond the right margin are received on-line and does station disconnect when EOT is received?	Place in service.	Check Page 2-1, A. VARIABLE FEATURES, 433 or 435. If OK, trouble is in station.

PART 3 -- ROUTINE SERVICING (Cont)
B. PERIODIC CHECKS, LUBRICATION AND CLEANING (Cont)

1. GENERAL

This part provides routine servicing procedures for the 43 Teleprinter Basic KSR Station.

Routine servicing should be performed, at the convenience of the customer, at least once a year.

Routine servicing consists of visual checks, lubrication, and cleaning. When performed at routine intervals, the possibility of later troubles will be reduced.

Following the routine servicing, a local and on-line installation checkout should be performed. The routine servicing date should be filled out on the bottom side of the directory card holder.

2. VISUAL CHECKS

The following areas should be checked for mechanical condition:

a. Frayed belts on spacing and line feed motors
b. Worn or frayed ribbon
c. All cable connectors fully seated (Page 3-8).
d. Print head cover fully seated.

3. CLEANING AND APPEARANCE

Examine exterior areas for smudges, dust, etc.

Check proper fit of cover. Replace extremely damaged or discolored cover, housing, bustle, etc.

Exterior cleaning should normally be limited to wiping with a soft cloth moistened with a mild detergent. However, in case of ink stained plastic surfaces, a waterless (nonabrasive) hand cleaner or a lather from abrasive bar soap applied with a cloth should be used.

Interior areas should be examined with the cover opened and accumulations of paper dust or ribbon fragments cleaned by carefully brushing loose material onto a cloth. Ink stains or deposits on interior surfaces, ribbon rollers, platen, etc, can be wiped with a cloth dampened in mineral spirits.

WARNING: DO NOT ALLOW MINERAL SPIRITS OR SOLVENTS TO CONTACT EXTERIOR PLASTIC SURFACES.

4. LUBRICATION PROCEDURES

The printer can be lubricated by opening the cabinet cover. Apply lubricant to points as indicated on Pages 3-6 and 3-7.

On small parts, a minimum amount of lubricant should be applied so that the lubricant remains on the parts and does not run off.

Excessive lubricant should be removed with a dry, lint-free cloth.

The following areas must be kept dry, free of all lubricant: All electrical components, including terminals. All parts normally touched by the operator, including exposed surfaces in ribbon, paper handling areas, and all large flat areas.

The following symbols indicate the quantity of lubricant to be used in a specified area: Symbols 01, 02, 03, etc, refer to 1, 2, 3, etc, drops of oil.

The following list of symbols applies to the lubrication instructions and the type of lubricant to be used:

O	Oil 88970 (1 qt), 88971 (1 gal), 318775 (4 oz).
G-A	Apply thin film of 97116 (4 oz) or 88973 (1 lb) grease.
G-B	Apply thin film of Syn-Tech grease (use 430836 tube with grease and 430838 brush).
G-C	Fill with Poly Oil grease (use 430837 injector with grease).
S	Saturate felt oilers, washers, and wicks with oil.
D	Keep dry, no lubricant permitted.

Lubrication Check List: (See Pages 3-6 and 3-7.)

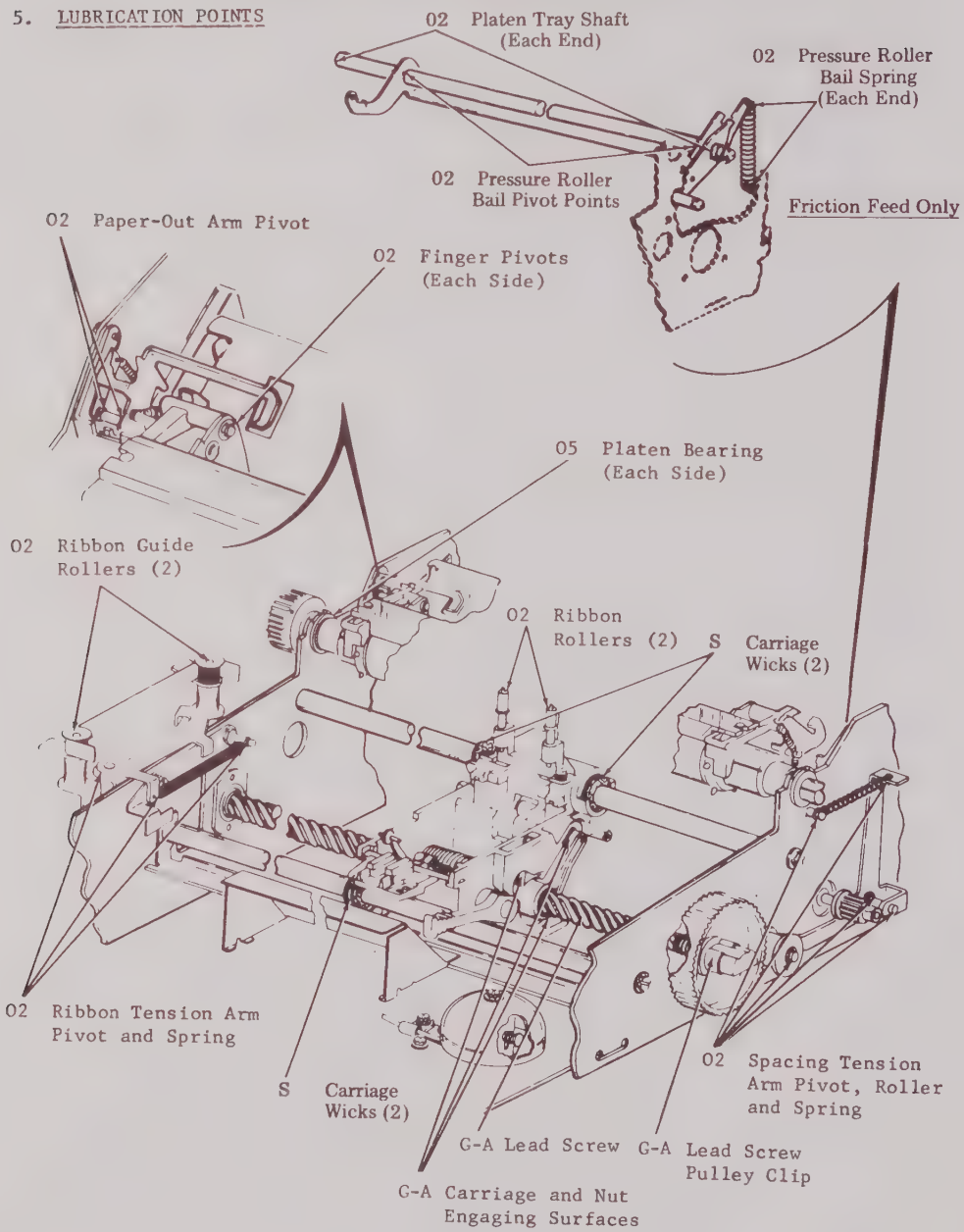
Lead Screw -- Film of grease over entire threaded portion of lead screw.
Carriage Wicks -- Saturate with oil (4 places)
Ribbon Guide Rollers -- 2 drops of oil (2 places)
Ribbon Rollers -- 2 drops of oil (2 places)
Ribbon Tension Arm Pivot and Spring -- 2 drops of oil each (4 places)
Spacing Tension Arm Pivot, Roller and Spring -- 2 drops of oil each (4 places)
Platen Bearing -- 5 drops of oil each side (2 places)
Finger Pivots -- 2 drops of oil each side (2 places)
Paper-Out Arm Pivot -- 2 drops of oil on both pivot points (sprocket feed only).
Lead Screw Pulley Clip -- Grease between clip and lead screw shaft.
Pressure Roller Bail Spring -- 2 drops of oil each end (2 places - friction feed only).
Platen Tray Shaft -- 2 drops of oil each end at the side plates (2 places - friction feed only).
Pressure Roller Bail -- 2 drops of oil each end at pivot points on each side of bail (2 places - friction feed only).

Carriage and Nut Engaging Surfaces:
a. Two Nut Drive Arms -- Grease four bearing surfaces.
b. Nut Keying Arm -- Lubricate by packing carriage engaging slot with grease.

Print Head:
a. Active Armatures and Outer Pole Plate -- Grease at the upper pivot area as well as the lower locator area (9 places).
b. Print Wire Well Area -- Completely fill with grease.

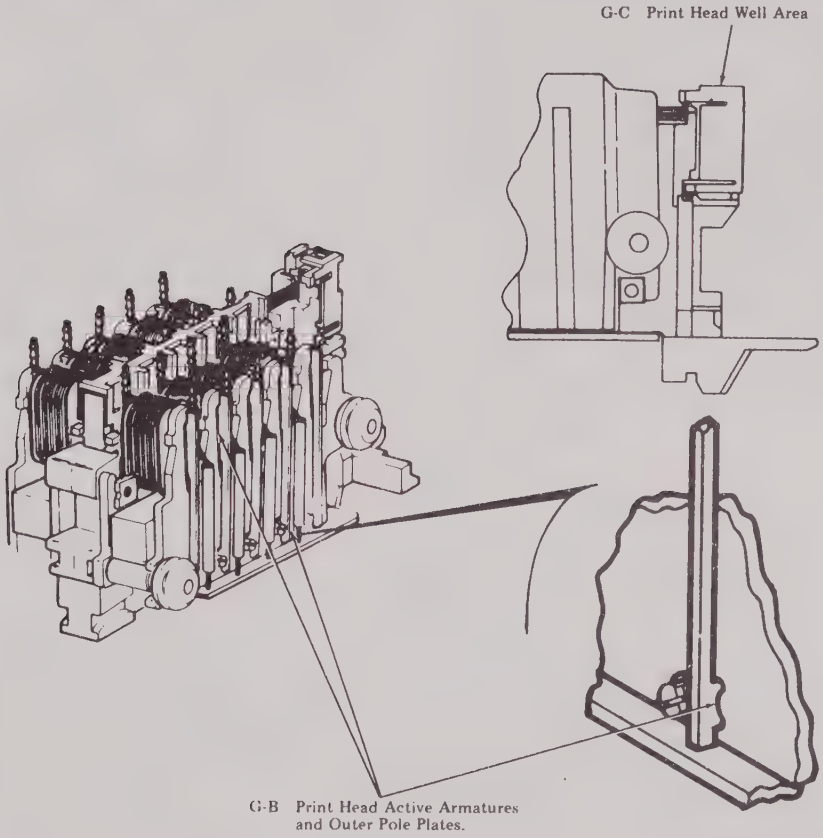
PART 3 -- ROUTINE SERVICING (Cont)
B. PERIODIC CHECKS, LUBRICATION AND CLEANING (Cont)

5. LUBRICATION POINTS


02 Platen Tray Shaft (Each End)
02 Pressure Roller Bail Spring (Each End)
02 Pressure Roller Bail Pivot Points
Friction Feed Only
02 Paper-Out Arm Pivot
02 Finger Pivots (Each Side)
05 Platen Bearing (Each Side)
02 Ribbon Guide Rollers (2)
02 Ribbon Rollers (2)
S Carriage Wicks (2)
02 Ribbon Tension Arm Pivot and Spring
S Carriage Wicks (2)
02 Spacing Tension Arm Pivot, Roller and Spring
G-A Lead Screw
G-A Lead Screw Pulley Clip
G-A Carriage and Nut Engaging Surfaces

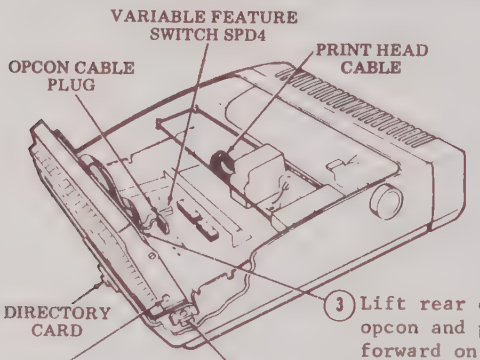
PART 3 -- ROUTINE SERVICING (Cont)
B. PERIODIC CHECKS, LUBRICATION AND CLEANING (Cont)

5. LUBRICATION POINTS (Cont)



PART 3 -- ROUTINE SERVICING (Cont)
C. COMPONENT ACCESS

1. Operator Console (Opcon), Cables, Directory Card and Variable Feature Switch

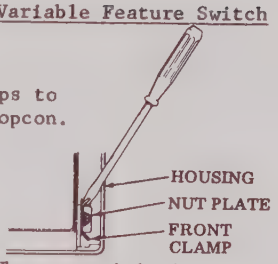


(1) Loosen (2) screws (one each side).

(2) Loosen (2) bushing clamp screws (one each side).

(3) Lift rear edge of opcon and pivot it forward on front mounting bushings.

(4) Reverse steps to reposition opcon.

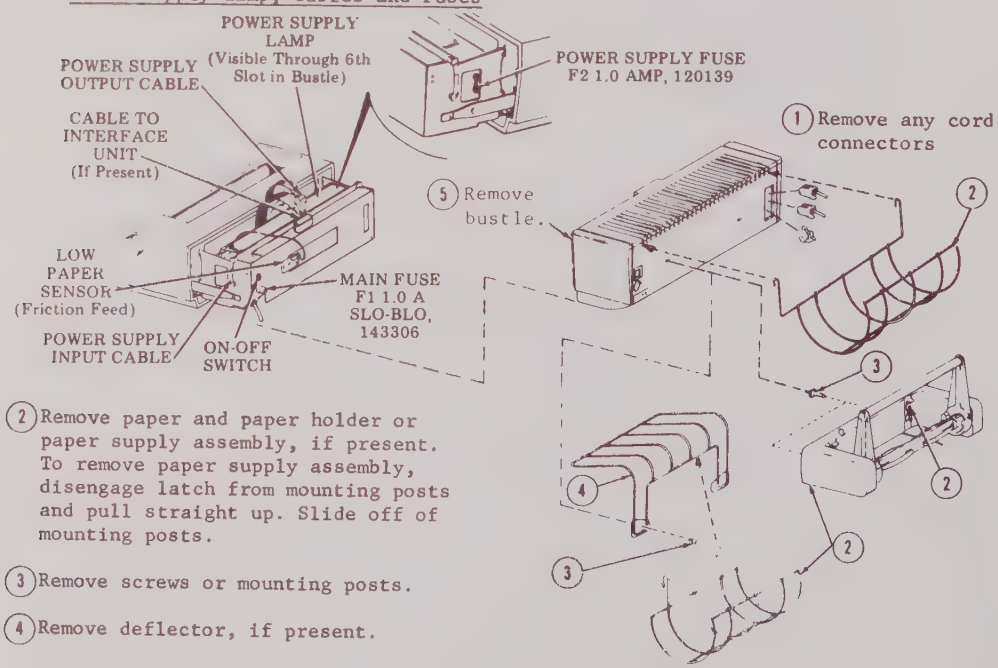


NOTE: When repositioning opcon, insert a screwdriver into the square hole in the nut plate and gently twist (or pry) the screwdriver with enough force to draw the assembly forward.

CAUTION: DO NOT OVERTWIST THE SCREWDRIVER.

Tighten the clamp screws.

2. Power Supply Lamp, Cables and Fuses


POWER SUPPLY LAMP (Visible Through 6th Slot in Bustle)
POWER SUPPLY FUSE F2 1.0 AMP, 120139
POWER SUPPLY OUTPUT CABLE
CABLE TO INTERFACE UNIT (If Present)
LOW PAPER SENSOR (Friction Feed)
MAIN FUSE F1 1.0 A SLO-BLO, 143306
POWER SUPPLY INPUT CABLE
ON-OFF SWITCH
(1) Remove any cord connectors
(5) Remove bustle.
(2)
(3)
(4)

(2) Remove paper and paper holder or paper supply assembly, if present. To remove paper supply assembly, disengage latch from mounting posts and pull straight up. Slide off of mounting posts.

(3) Remove screws or mounting posts.

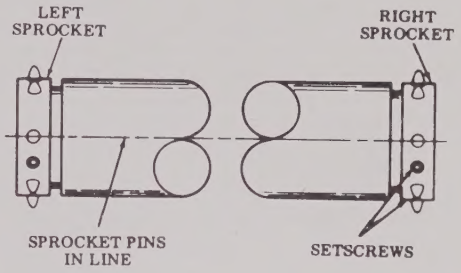
(4) Remove deflector, if present.

PART 3 -- ROUTINE SERVICING (Cont)
D. ADJUSTMENTS

RIGHT PAPER SPROCKET (Sprocket Feed Only)

Requirement
The right sprocket should be biased against the collar of the platen hub and the pins should be in line with the pins of the left sprocket.

To Adjust
Loosen setscrews and position right sprocket to meet requirement.



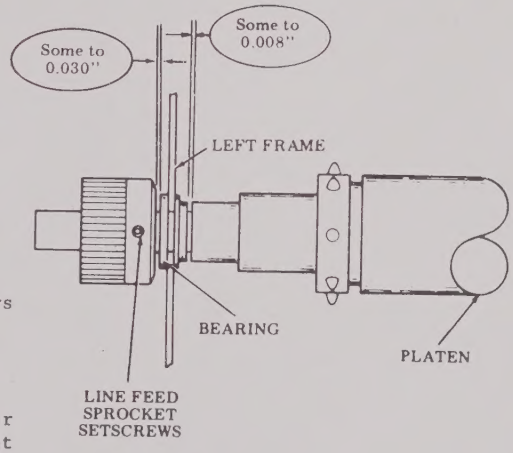
PLATEN ENDPLAY AND PRINTED LINE POSITION

The following two requirements must be met:

(1) Requirement
Platen Endplay -- With the platen biased against the right bearing, there should be
Min Some---Max 0.008 inch
clearance between the left bearing and the platen hub, at the closest point, and
Min Some---Max 0.030 inch
between the left bearing and the sprocket at the closest point.

(2) Requirement (Sprocket Feed Only)
Printed Line Position -- The lower edges of a typed line of M characters should be 1/32 ±1/64 inch above a horizontal line located by any of the following methods:

(a) A line drawn between the lower edges of two opposite sprocket holes.
(b) A preprinted line on the form the same as in (a) above or in 1/6 inch multiples.
(c) A fold midway between two sprocket holes on fanfold paper.



(Power must be on line feed motor for this adjustment.)

To Adjust
Loosen the line feed sprocket (at platen) setscrews and position. Print the character "M" across the line and check (2) Requirement. If necessary, loosen setscrew on right sprocket to meet alignment requirement.

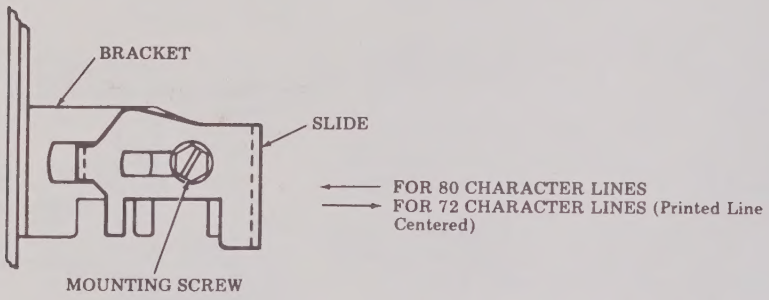
LEFT-HAND MARGIN (Friction Feed Only)

Requirement

When the variable feature switch arrangement on the printer logic card has been enabled for 80 character lines, the slide should be located all the way to the left. When the switch arrangement has been enabled for 72 character lines and printed line centering (Option 432d) is required, then the slide must be located all the way to the right.

To Adjust

Loosen the single mounting screw holding the slide to the bracket and move the slide to meet the adjustment.



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